# UTILITIES TARGET MANUAL

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## FOREWORD

This publication is a practical guide for the preparation and use of utilities targets. It is written specifically for engineers of the Public Works Center, Public Works Department, Naval Facilities Representative, and Engineering Field Division.

This manual supersedes MO-303, Guide for the Development and Use of Utilities Targets, dated January 1966.

This publication is certified as an official publication of NAVFAC and has been reviewed and approved in accordance with Secretary of the Navy Instruction 5600.16.

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CONTENTS

CONTENTS (Continued)



ILLUSTRATIONS

## TABLES

TABLES (Continued)

1.1 PURPOSE. The Navy utilities systems have a current replacement value in excess of 4 billion dollars and require more than 8,000 people and 250 million dollars, annually, to operate and maintain. Management of this vast complex demands the most effective application of four basic functions: planning, organizing, directing, and controlling. A weakness in any one of these four functions will prevent achieving the goal of dependable, economical utilities service in support of the Navy's air-sea mission.

The last of these four functions, controlling, consists of:

(1) Measurement of the results obtained from managerial actions and policies.

(2) Analysis and comparison of these results with those desired.

(3) Determination and initiation of the necessary action required to correct the undesirable condition.

The targets program provides procedures for estimating quantities and costs for optimum utilities operation and maintenance and for comparing these with actual usage and expenditures. Thus, the targets program is a management tool for effective utilities control. Estimating procedures developed through the targets program can be used by shore activities to determine and justify the resource requirements, both money and utility service, necessary for proper operation of their facilities in the most economical way.

This manual provides a practical guide for the actual preparation and use of the utilities targets as well as the rationale behind them. It is specifically written as a guide for engineers of the Public Works Center or Public Works Department, Naval Facilities Representative, and Engineering Field Division (EFD), who are responsible for providing efficient and effective utilities services at the activity level.

1.2 PROGRAM DEVELOPMENT. The initial Utilities Conservation Survey Guide of 1957 established a method for preparing quantity targets for steam, water, and fuel. Subsequently, targets were developed for electrical quantity usage as well as for the unit costs of steam, electricity, and water. The field-tested revisions to these methods were issued in 1966 as the Guide for the Development and Use of Utility Targets, MO-303.

As originally conceived, targets were before-the-fact estimates of utilities quantities and costs, based on historical data and projected conditions. As more experience was gained with the program, it became evident that the use of the targets as an accurate management tool dictated the computation of after-the-fact targets. To obtain the needed accuracy, the variable inputs to the target (that is population, equipment operating time, and weather) should now be derived from actual past records of the target period rather than from estimates. As a result, the target will be a more accurate reflection of what actually took place in the system during the period. The targets developed in this manual are

ned primarily for use as management indicators, using actual input
This concept provides an indication of system condition, operation,
ciency and use comparable with the Resources Management System
osophy.

As a secondary use, the target procedures can and should be used to elop accurate estimates of future utilities quantities and costs to rmit effective resources and budget planning. It should be remembered at the figures developed for this future estimate rely heavily on the ccuracy of the predictions of population, equipment operating time and eather. Such targets provide the most accurate available estimates of utilities quantities and costs, but the variance of future actual quantities and costs from estimates should not be used as an indication of management effectiveness since any subsequent changes in population, equipment operating time and weather can invalidate a before-the-fact target.

Targets are developed for Naval Shore installations by the EFD and are periodically reviewed and updated as part of the EFD's utility conservation program.

1.3 TARGET DEFINITION. Utilities targets are defined as goals for utility management which are attainable with efficient system operation, adequate maintenance, and conscientious conservation. They represent the best production, distribution, and utilization performance which could be realistically expected at the studied activity with the existing equipment, loads, and conditions. This optimum utility performance is expressed as the target. Target quantities and costs thus enable management to see how close actual values come to optimum performance.

Targets described in this manual recorded on the Utilities Cost Analysis Report, NAVCOMPT Form 2127 (UCAR), and used in evaluation of utilities management are after-the-fact computations which will indicate problem areas requiring immediate managerial attention. The same procedures can also be used to project before-the-fact calculations for the purpose of budget estimation. Utilities targets are separated into two distinct types: the quantity target and the unit cost target. A complete evaluation of a total utility system can only be made by studying both simultaneously.

1.3.1 Quantity Targets.

1.3.1.1 Net Utility Consumed Quantity Target. This target is the total of all utility quantities which should have been consumed by station activities under control of the command responsible for providing the utility.

1.3.1.2 Net Utility Delivered Quantity Target. This target is the total of the Net Utility Consumed Target and all quantities delivered to activities not controlled by the command responsible for providing the utility.

1.3.1.3 Net Utility Produced and Purchased Quantity Target. This target is the total of the Net Utility Delivered Target and the targeted allowance for distribution losses.

1.3.1.4 Net Utility Produced Quantity Target. This target is the total quantity that should have been produced. Where applicable it may be developed from the Net Utility Produced and Purchased Target on the basis of the economical proportion of produced to purchased utility.

1.3.1.5 Non-Target Quantities. Uncontrolled reimbursables are not considered targetable because the utility supplier has no direct control over usage. Examples of reimbursable customers are Officers Open Mess, exchanges, contractors, and ships. Although commissaries and Navy housing are considered as reimbursables for budget and appropriation purposes, they should be included in the computation of target quantities if their consumption is controlled by the reporting activity.[1]

Interutility transfers can be targeted separately with the end use utility to determine operating efficiency. If possible, actual quantities of non-target uses should be obtained by direct meter readings. For those areas in which separate utility meter readings are not available, estimates must be made, based on the most realistic approximation of such factors as workload and equipment operating records. Portable meters may help to establish a ratio of usage to production output, customer operation or some other indication of utility use.

1.3.1.6 Special Quantity Targets. These targets can be developed for utility uses and classes in addition to those reported on the UCAR. The more concise the uses measured and compared with expected performance are, the more evident the basis for managerial decision, and the more effective the resultant actions will be. By measuring the performance of the major use quantities of a utility system, control of the whole system is made more feasible. For example, interutility transfer quantities can be targeted and compared with the actual quantity of one utility transferred to another.

1.3.2 Unit Cost Targets. These targets are engineering determinations of the lowest unit cost attainable for the actual utility quantity Produced or Delivered during the period targeted. The unit cost targets indicate how much each unit of the actual utility quantity provided should have cost if the existing utility system had been operated with optimum effectiveness. The unit cost target can be separated for each utility into two types: the Unit Cost Target Produced and the Unit Cost Target Delivered.

1.3.2.1 The Unit Cost Target Produced. This target is compared with the actual "Unit Cost Produced", as reported on the UCAR, and is defined as the targeted gross plant production costs divided by the actual net utility produced (gross production quantity minus the actual quantity of the utility used in production).

$$\mathrm{UCTP} = \frac{\mathrm{TPC}}{\mathrm{NUP}} \qquad (1\text{-}1)$$

where UCTP = Unit Cost Target Produced,
TPC = Targeted Gross Plant Production Costs, and
NUP = Net Utility Quantity Produced.

[1]But see Chapter 2, par. 2.2.7, for reimbursable electrical loads that should be targeted.

The Targeted Gross Plant Production Costs consist of:

(1) Operations Costs: labor, fuel, material, contractual and other.

(2) Maintenance Costs: labor, material, contractual and other.

(3) Overhead Costs: apportioned general plant expense and general expense applied (NIF).

(4) Costs of Interutility Transfers (to).

Target allowance figures, based on existing data, can be developed for some of the components of the gross plant production costs above for each utility. As more target cost data becomes available for the different utilities, more of these costs will be targeted. The unit cost target format will remain as described in this manual and actual costs will be used where target allowances are not as yet available.

The Unit Cost Target Produced is used primarily to spot excessive costs in the various elements of production. Used in conjunction with the quantity targets, this target assists management in assuring the lowest overall Production (O&M) costs for the quantity of utility services needed.

1.3.2.2 The Unit Cost Target Delivered. This target is compared with the actual "Unit Cost Delivered" as reported on the UCAR, and is defined as: the total targeted cost of utilities delivered, divided by the actual net quantity of the utility delivered. The total targeted cost of utilities delivered includes: the targeted gross plant production costs (including the cost of interutility transfers to), plus the actual purchased utility costs, plus the targeted cost of distribution, minus the cost of interutility transfer from.

$$UCTD = \frac{TPC + APUC + TCD - IUTC}{AQD}, \qquad (1-2)$$

where
UCTD = Unit Cost Target Delivered,
TPC = Targeted Gross Plant Production Costs,
APUC = Actual Purchased Utility Cost,
TCD = Targeted Cost of Distribution,
IUTC = Interutility Transfer Cost (from), and
AQD = Actual Quantity Delivered.

The Targeted Cost of Distribution includes:

(1) Operations Costs: labor, material, contractual and other.

(2) Maintenance Costs: labor, material, contractual and other.

(3) Overhead Costs: apportioned general plant expense and general expense applied (NIF).

Target allowance figures, based on existing data, can be developed for various components of the cost of distribution above, for each utility. As more target cost data becomes available for the different utilities, more of these component costs will be targeted. The unit cost target format will remain as outlined in this manual and actual costs will be used where target allowances are not as yet available.

The Unit Cost Target Delivered is used primarily to spot excessive costs of the various elements of utility distribution, as well as production, for utilities which are both produced and purchased. The use of this unit cost target, in conjunction with the quantity targets, enables management to insure the lowest overall cost to the users, for the utilities actually needed.

1.4 TARGET USES. The Utility Targets indicate, to all levels of management, the quantity of a given utility that should have been produced and the cost that should have been incurred during a specific period. With this information, management can evaluate the operation and maintenance of the utility system on a general basis and direct effort, when and if needed, for improvement. When actual utility usage exceeds targeted amounts, review of the individual target components assists in locating the specific areas where corrective action is needed.

At the activity and EFD level, the targets, used together with a basic knowledge of the activity's utilities systems, can accomplish the following:

(1) Spot areas of utilities wastage or inefficient operation or maintenance as soon as an undesirable condition occurs.

(2) Determine equitable billing rates for reimbursable tenants when the installation of meters is not economically justified.

(3) Provide a consolidated information source to maintain a current inventory and help in the evaluation of utility equipment condition.

(4) Prepare, support, appraise and justify budget requests, by realistic estimation of the utility quantities and costs required.

(5) Develop, justify and validate future requirements-planning information by comparing existing plant capacity with estimated future requirements.

(6) Develop, justify and validate desired repairs, replacements and system expansions, on the basis of increased efficiency or reduced wastage.

(7) Estimate potential savings available through conservation efforts and thus aid in publicizing and promoting the conservation program.

(8) Familiarize personnel directly responsible for management of the utilities systems with the current condition and components of these systems.

(9) Provide an accurate method for estimating the output of a plant lacking adequate metering.

At the Command and EFD level the Utility Targets can also be used to:

(1) Monitor the activity's use of operation and maintenance funds by the technical analysis of the performance of each of the utilities system components as well as the overall system.

(2) Validate activity budget requests.

(3) Support special and MilCon projects.

1.5 ANALYSIS OF TARGET VARIATIONS. Whenever the actual quantity of the utilities Produced and Purchased exceeds the comparable, computed target allowance by 10 percent or more, the individual target components should be re-checked to assure that they have been correctly computed and/or identify the specific cause of utility loss. When the actual usage exceeds the target allowance, the difference represents the potential savings possible through corrective action.

It should be kept in mind that the targeting procedures developed in this manual are provided as a <u>guide</u> for the development of useful utilities targets. They are considered <u>good</u> methods whereby accurate approximations can be made in a reasonably short period of time. Other allowance estimates can, of course, be made using acceptable engineering methods such as ASHRAE heating and cooling load estimates, industry accepted electric load factors, etc.

EFD personnel should consider how expensive a utility is per unit, how it is consumed, the predictability of consumption, and the likelihood of savings due to frequent and detailed target analysis when establishing the scope and period of the target calculations. Further guidance along these lines accompanies the treatment of each separate utility.

1.6 SUMMARY. The Utility Target program provides the best available tool for insuring proper operation and realistic conservation of the Navy's utilities resources. But more important, the procedures developed in the Target program can help the people responsible for the operation and maintenance of the utilities systems do their job better and with less effort. It should always be remembered that the targets were developed specifically to help the Activities/PWC's, and the allowances, factors, calculations etc., should be applied with this purpose in mind.

## CHAPTER 2. TARGETS FOR ELECTRICITY

2.1 PROCEDURES FOR DEVELOPING TARGETS. This chapter sets forth procedures for developing targets that will both serve as criteria for the efficiency of overall plant operation and bring to light specific areas where improvements can be made. The target data will be accumulated and developed in a manner that follows the physical arrangement of the facility's electrical system. In this way individual targets are developed that reflect, for example, the target for consumption on each secondary distribution feeder, and these in turn can be combined to reflect the consumption on primary feeders.

These procedures are an extension of the procedures used in past years. The latter consisted essentially of grouping all like loads, in terms of building use codes and special loads, throughout the activity and setting an overall target. The methods described herein consist of grouping like loads on each feeder to obtain target values, and then combining the feeder targets to obtain a total for the activity. It is recognized that some initial effort may be required in setting up these procedures, and this will be especially true at older activities where up-to-date one-line diagrams do not exist. In such cases, continue grouping all like loads for the activity to calculate electrical targets until connected loads are inventoried and diagrams are updated.

The feeder method of electrical targeting has the basic advantage that it uses the same tools and approaches as other types of engineering analysis (including the initial design), and thus it benefits from these analyses and contributes to them. Among the many specific advantages are:

(1) The persons preparing the targets can use the one-line diagrams prepared in the system design as the heart of the targeting procedure, or if one-line diagrams must be prepared to facilitate targeting, they are also immediately available for engineering analyses.

(2) Improvements in distribution will become readily apparent, and in some cases, as with loop and network distribution circuits, may be made by manipulating existing switchgear.

(3) The exercise of preparing targets by this method will familiarize personnel with the physical layout of the electrical systems and will provide and reinforce training.

(4) Management Assistance Team and other surveys subsequent to the target analysis will be simplified. For example, excessive energy consumption or demand can be traced to feeders that are metered or can be easily metered during the survey.

(5) The need for limited capital improvements, such as additional distribution substations near load centers (for long-run economy) or circuit ties (to protect vital loads) will be brought out by the targeting process.

This chapter will cover: Quantity and Unit Cost Targets for typical activities with a mix of different types of facilities. It will then discuss the special problems of such activities as radar and communications stations and activities with predominantly industrial loads - activities that do not lend themselves readily to targeting by normal means. Specific examples of targeting procedures will be given.

2.2 QUANTITY TARGETS. The use of electricity at a Naval activity is a function of many variables: such as number of personnel, length and number of work shifts, type of equipment installed, building size, and mission. The effects of all of these factors, in developing electrical quantity targets, except the building areas and the connected power loads, will be minimized. The other variables are still considered, but indirectly, as they are accounted for in the application of the Usage Factors. Prior to the development of quantity targets, there are certain terms which should be defined.

(1) Demand factor. The ratio of the maximum demand of a system to the total connected load of the system.

(2) Load factor. The ratio of the average demand of a system over a given period of time to the peak demand of the system occurring during that same period of time.

(3) Coincidence factor. The ratio of the maximum coincident demand of a system to the sum of the individual maximum demands of the components of the system.

2.2.1 The One-Line Diagram. The one-line diagram uses single lines and simplified symbols to show the course of circuits, the control and protective elements in the circuits, and the equipments and panels served by them. Typically (Figure 2-1), a complex activity's electrical system will be diagramed in a series of drawings, starting at the top with a distribution diagram showing main substations (for example, 66/13.2 kv. transformers or 6.9 kv. transformers) and the primary distribution lines through the local transformers (for example, 13.2 kv./440 or 13.2 kv./240/120 v. transformers). Subsequent drawings might show, for example, 440 volt systems to major equipments on a building by building basis (Figure 2-1, Sheet 2), and so on down to miscellaneous services, including low voltage pieces of fixed equipment (fans, control motors, etc.) and connections to service panels. In load center distribution systems, in which local substations step down the voltage for distribution to adjacent individual facilities, or groups of facilities, or individual functions such as street lighting, the one-line diagrams are developed in a logical sequence that reflects the functions and physical layout of the activity as well as the electrical system. In so-called piecemeal distribution systems — distribution carried long distances over secondary feeders at low voltages from one or two main substations — the setup may be much less neat and logical, and complete, up-to-date drawings are less likely to exist. Yet here the development of good one-line diagrams, with the accompanying inventory of loads and distribution equipment, is most like to pay off, both in terms of more economical operation of the existing system and as the starting point in a program of improving the system and taking advantage of the economies inherent in high or intermediate voltage distribution to local transformers. One-line diagrams should be developed in accordance with MIL-STD-15, Graphic Symbols for Electrical and Electronics Diagrams, U.S. Government Printing Office, latest revision.

2.2.2 Adapting the One-Line Diagram to Target Preparation. The following information should be keyed to a copy of the one-line diagram, if it does not appear. (See Figure 2-1 for an example):

(1) Meters. The meters for each primary and secondary distribution feeders, and connection points for temporary metering.

(2) Building Data. A complete listing of the existing structures supplied by each distribution feeder, including tenant facilities, identified by their respective Navy Codes, and the square foot area occupied by each code is required. This information is most easily obtained from Parts I and II of the "Detailed Inventory of Naval Shore Facilities — Real Property, "11ND-CBC 11000/1A (REV 4-63), (Table 2-1). Inspection of this inventory, located in the plant accounts section of the Public Works Office, will establish the areas for which a target will be calculated. The general load (lighting and small devices) will be targeted on the basis of code and square footage, as described in a later paragraph. Do not include spaces unused during the target period.

(3) Connected Power Load Data. Connected power load shall be defined as all electrical power-consuming equipment of 2 hp. or 2 kw. and above which has been or will be operated during a period of one year (use the approximation: 1 hp. equals 1 kw.). Box 8, Section 1 and Box 42, Section V of the DD1342, Class III and IV property record cards (Table 2-2) located in the fiscal office of the activity, may be utilized in determining the size and location of certain power equipment. It is the responsibility of each activity to record information requested on these cards in accordance with the instructions as set forth in paragraph 036115, Volume 3 of the "Navy Comptroller Manual" (NAVEXOS P-1000). Experience has shown that this approach may be used in lieu of an overall field inspection without materially affecting the accuracy of the resultant values. However, the ratings on non-motorized electrical equipment, such as ovens, may not be listed on these cards; or if a rating is given, it may refer to a fractional hp. motor attached to the equipment and not to the total rating of the unit. When this occurs, it will be necessary to compute the kw. rating from information obtained from the "description" section of the card Box 18, Section II. This calculation approach may also be necessary when analyzing electrical motorized equipment having a purchase price less than $500. Should neither of these methods provide the necessary information, field inspection will be required. It is important to note that the thermostat-controlled heating and cooling equipment (furnaces, ovens, refrigeration plants, etc.) cycle on and off during their hours of operation. When estimating power load in houses, consider only electrical ranges, dryers, hot water heaters, dishwashers and air conditioners.

(4) Connected Air Conditioning and Electric Heating Loads. Targets for air conditioning are calculated separately, on the basis of weather data, as described in Chapter 5 of this manual. However, the data for feeder, and the purpose of identifying the loads at this time is to make it possible to apportion the target values to the correct feeders. Similarly, electrical heating space will be calculated on the basis of weather data in accordance with paragraph 2.2.3, below, and will be apportioned as indicated on the one-line diagram and associated listings.

(5) Outdoor Lighting. Identify by type, number of lights, rating, and, where applicable, kinds of use (intermittent or all night):

Street lighting, zone A — 52 mercury at 400w.
Flood, drydock #1 — 52 fil. at 1000w., intermitt. ovhl.
Protective, Res. receiving, whse. #6, — 8 flour. at 1000w. all night 7 days a week.
Storage area #7 (inactive) — 12 fil. at 500.

Together with sunrise and sunset data, the foregoing will be converted to target usages, as described below in paragraph 2.2.3. Outside lighting data should be available in the utilities division. If not, an inventory will be required. If possible, they should be recorded on the basis of individual lamps, as shown above; this will facilitate future target adjustments and also demand calculations in connection with system expansions.

(6) Capacities of outlets for piers.

2.2.3 Preparation of Energy Targets.

(1) Service Loads. The average power consumption for service loads (lighting and other equipment rated at less than 2 kw.) is targeted by multiplying the area (in square feet) serviced by the feeder in each Navy building code designation by usage factors, which comprise normal unit connected loads in terms of watts/ft$^2$, and load and coincidence demand factors. The factors for the various code designations have been obtained on the basis of experience, and are listed in Table 2-3.

(2) Loads of 2 kw. and up. Average power consumption for connected loads other than service, special heating, air conditioning, and exterior lighting loads is similarly targeted by applying factors comprising load and demand factors to the kilowatt rating of the equipment. Table 2-4 illustrates items (1) and (2).

(3) Computing target kw.-hr. for items (1) and (2). The targeted average power is summarized for the foregoing items and multiplied by the number of hours in the target period (8760 per year, 2190 per quarter, 744 per 31-day-month). See Table 2-7.

(4) Special loads. Special loads are loads that do not lend themselves to targeting by using factors based on experience, either because the equipment itself is special (such as centrifuges and other special test equipment), or because it is used unpredictably (such as communications transmitters, equipment for emergency repairs or pumps used to alleviate flooding). If possible, these should be targeted on the basis of kw. rating and logged or estimated length of use. For further discussion, see paragraph 2-4. Table 2-5 is a sample special-load calculation (see also Tables 2-8 and 2-21).

(5) Air conditioning loads. These should be targeted separately (including total air conditioning loads made up of wall units of less than 2 kw. each) on the basis of type, size and shape of building, class of insulation, and average wet and dry bulb temperatures during the target period. Chapter 5 described in detail how to compute air conditioning loads, and how to convert tons of air conditioning into electric power and energy requirements.

(6) Electric heating loads. As with air conditioning, electric heating should be computed on the basis of size and shape of buildings, insulation factors, and degree days during the target period. To obtain the total target value of B.t.u.'s of heat that should have been consumed on the feeder over the target period, follow the methods described in Chapter 4, paragraph 4.3, Building Heating Allowance. The target electrical

energy consumption is obtained by:

$$E = 0.000293\ Q,$$

where $E$ = energy in kw.-hr. and
$Q$ = targeted heat consumption in B.t.u.

(7) Outdoor lighting loads. The outdoor lighting loads should be broken down into categories of lamp rating and type of use (all night or partial use). The reasonable hours of illumination for the time of year are then applied. Examples are:

Street lighting: average hours, sunset to sunrise, during target period.
Security lighting: average hours, sunset to sunrise.
Floodlighting of working areas: average hours, one hour before sunset to end of last working shift.
Parking lot floodlighting: average hours, sunset to one-half hour after end of last working shift, plus duration of special events requiring evening use of parking lots (the base security office will normally keep records of such special off-hour uses).

Steps should be taken to ensure that other special uses of significant outdoor lighting loads are recorded. These would include night runway and taxiway lighting at airfields not kept open for night flying on a regular schedule; and dockside lighting for non-recurring tests or night missions.

The total days in the target period must be considered carefully. For example, floodlighting of working areas would normally exclude weekends and holidays, but there may also have been periods of a six-day week. Street-lighting in some areas may be partly or wholly extinguished on weekends or after some hour of the night.

Where outdoor lighting is operated automatically by photoelectric devices or clock timers, the calculated energy target will serve as a check that the settings of the devices are in line with activity schedules. For this reason it is recommended that target calculations be made independently of the hours totalized on the automatic device.

The targeted energy for each category of rating and use is obtained by:

$$E = \frac{N \times P_r \times H_d \times D_w}{1000} \qquad (2\text{-}1)$$

where $E$ = energy consumption in kw.-hr.,
$N$ = number of lamps of a given rating,
$P_r$ = lamp rating in watts,
$H_d$ = reasonable illuminating hours per day, and
$D_w$ = working days in target period.
...with $H_d$ and $D_w$ adjusted to fit conditions at the activity as discussed above.

The energy targets for each category are summarized to give total lighting energy target. See Table 2-6 for a sample calculation.

(8) Energy Target for Feeder. The targeted energy consumptions for each of the above elements are added. Then apply factors for transformer and line losses. These are best calculated using transformer rated losses and the resistance data and length of wires of various gauges in the system. However, in some activities, especially older ones, these data will be hard to obtain; in this case, add 6 percent to the kw.-hr. total. These factors should be checked by metering, since line losses will normally be lower in new load-center distribution systems and higher in older systems with extensive low-voltage distribution, and a realistic target should reflect this. See Table 2-7 for a sample calculation.

(9) Energy Target for Activity. Combine the total kw.-hr. for the individual secondary distribution feeders to obtain target values for the primary feeder(s) and the activity.

2.2.4 Demand Targets. Demand divides itself into two categories: demand for the individual feeder and demand for the distribution network (usually for the entire activity, or the portion of the activity deriving its power from one source).

The maximum demand which each primary and secondary distribution feeder network can carry is determined by the kva. rating of the distribution transformers (assuming that the conductors in the system have been properly sized to avoid excessive $I^2R$ losses at rated transformer load and that the system is designed to maintain minimum required voltage at the end of the line without exceeding maximum voltages at distribution points near the transformer). In hot weather, transformers should be run at less than full rated load, by approximately 0.83 percent of rated kva. for every degree over 86° F. average for self-cooled transformers, 0.83 percent of rated kva. for every degree over 77° F. water temperature for water-cooled transformers, and 0.55 percent of rated kva. for every degree over a cooling fluid temperature of 77° F. for forced air and forced oil cooled transformers. (See NAVFAC MO-201, Operation of Electric Power Distribution Systems, Chapter 5, for transformer operation.)

For the distribution system as a whole, the demand target is determined by the contract with the local public utility company, the activity's own generating facilities, or both. Most activities fall into one of the following categories:

(1) All power purchased; a premium rate is charged for demand over a specified amount.

(2) Power normally purchased, standby generating capacity available for emergencies and peaks.

(3) Power normally generated at the activity, power purchased from the public utility company during peaks or generator downtime.

In the first case, demand should be kept below the premium rate limit. In the second, it should be kept below the maximum that would require facing the choice of incurring premium rates or using the activity's standby generator(s). In the third, there are usually two limiting factors: One is the limit of the activity's generating capacity; if power must be purchased, premium rates are often charged, either on a flat rate basis or as a function of either a demand limit for the activity or the activity's contribution to the utility company's total load. The other factor is the successive demand load limits requiring that additional generating capacity be put on the line.

However, the economical operation of the system can be affected by such conditions as the following:

(1) The need to keep demand above a contractual minimum to avoid premium rates for low consumption compared with the public utility's investment in supplying power.

(2) Use of extraction or topping turbines to supply steam for industrial uses, heat, and other turbogenerators.

(3) The need, at some activities, to have more generating capacity on the line than is required by operating equipment, to avoid a costly shutdown in the event of failure of a generator or primary feeder.

Where such circumstances exist, demand goals should be developed on the basis of engineering evaluation, and steps taken to control peaks in the manner that will prove most economical for the particular activity. See NAVFAC MO-305, Activity Conservation Techniques.

Demand may also be subject to arbitrary limits to prevent area brownouts. This is occuring with increased frequency in hot summer weather due to air conditioning loads and also during the winter due to combined heating, lighting and industrial loads. In such cases, the one-line diagram should be used as the basis for a planned program for successively eliminating or reducing non-essential loads.

If actual metered demand is well below premium rate levels, further targeting is not recommended. If maximum demand is 90 percent or more of premium rate levels, or if excessive additional generating capacity must be kept on the line to meet occasional peaks, demand should be targeted by applying demand usage factors to the connected loads and areas, for each type of building, as given in Table 2-3. These factors incorporate the demand factor and the coincidence factor and are based on experience at many naval activities (see Table 2-7, Item II, for demand target calculations).

2.2.5 Power Factor Targets. As a minimum, power factor should be maintained high enough to avoid penalty charges, if these are incorporated in the contract for purchased power. In any case, a power factor of 0.9 or better should be the target goal, with 0.95 to 1.0 the desired range.

2.2.6 When to Prepare Targets. Since meter readings and billings generally run on a monthly basis, target calculations at most activities should be made at the end of each month (or monthly billing period if it is not concurrent with the calendar month) for the previous month, even though the UCAR on which the target data are reported is prepared at considerably longer intervals. Monthly targeting of electricity has three advantages:

(1) It permits the Utility Division to supplement records with memories of unusual events while they are still fresh: such as shutdowns caused by bad weather, operation of high voltage research equipment, and special demands by ships or other reimbursables.

(2) It permits the adjustment, over a period of time, of target calculations to account for cyclical variations during the year. In the methods outlined here, the cyclical changes in air conditioning, electrical heating, and major lighting loads are factored in, but each activity will have others that may be regular enough to attach an arithmetical value to and apply as a factor in subsequent years.

(3) Trouble areas will be revealed early and can be corrected before

they become costly.

Facilities that are charged for demand on the basis of annual peaks will not find monthly demand levels significant. However, in many cases there is a ratchet clause in the contract with the electric utility company that calls for 100 percent demand charges in the month when a maximum is exceeded, 90 percent (or some other lesser amount) the next month, and so on until 0 percent is reached. In such cases, a demand target should be developed. It provides a tool for ensuring that demands are not excessive in subsequent months, so as to drive demand charges back up.

2.2.7 Reimbursable Consumers. It has been the custom at many activities to exclude some or all reimbursable consumers from electrical targeting. However, the reimbursable consumers at a majority of naval activities are substantial users of electric energy, and at many they can, through bad planning, push the activity's total load into the premium demand range. Good management calls for targeting these reimbursables. The means of setting up targets will vary with the activity and the type of reimbursable consumer. Normally the following procedures will be used:

(1) The utilities division of the supplying activity will set up targets for functional units within the activity and clearly related to it, such as:

The Navy Exchange.
Officers' Mess.
Laundry.
Naval Housing.
School and Training Facilities.

(2) Larger, semi-autonomous activities will prepare their own targets, with technical assistance from the supplying activity's utility division, the public works center, or the NAVFAC Engineering Field Division. Such activities would include:

Supply Depots.
Research and Development Centers.
Hospitals.
Larger Schools that are Independent of the Supplying Activity (for example, Training Stations, Officers' Candidate School, War College).
Communications Centers.

(3) Transient reimbursables, such as ships, will be targeted by the base utilities division, working with the chief engineer or other cognizant person in the using facility.

(4) Reimbursables who are not under USN jurisdiction will be treated like the customers of a public utility company and will not be targeted. These would include:

Municipalities.
Army, USAF, GSA, and other federal facilities.
Utility companies and private industrial customers.

Navy housing should be included in this category if it is outside the activity and cannot be included in the activity's conservation program (see MO-305).

A total actual expenditure should be included for non-targeted facilities in the target calculation, based on meter readings for the target period. If the non-targeted facility is not metered, the entire target calculation for the targeted areas may be invalidated; metering should be installed as soon as possible. However, in the case of minor non-targeted reimbursables, engineering judgments based on experience with similar facilities may be substituted.

2.2.8 Interpretation of Quantity Targets. The comparison of actual quantities to target values will always indicate a discrepancy because perfect control of all factors of operation is impossible. The difference will provide a measure of the effectiveness of the operation, and significant deficiencies should be explained to the Public Works Officer. When the variance is greater than five percent, typical areas which should be investigated are:

(1) Excessive system losses due to oversized transformers.

(2) Excessive $I^2R$ losses due to improperly sized conductors or long low-voltage distribution runs.

(3) Improper scheduling of large power loads.

(4) Excessive system losses due to unnecessary voltage transformations.

(5) Use of oversized equipment, resulting in excessive motor losses.

(6) Excessive use and/or poor maintenance of street and flood lighting.

(7) Poor conservation practices in specific areas. (See MO-305).

(8) Accuracy of target input information.

2.3 UNIT COST TARGETS. Unit cost targets, based upon actual and targeted quantities, will be developed for the cost of utility purchased, produced, produced and purchased, and the cost of utility delivered. The electrical unit cost targets, like the electrical quantity targets, will be prepared on a monthly basis. Prior to the establishment of unit cost targets, complete Table 2-11 as indicated.

2.3.1 Purchased Unit Cost Target.

(1) Use actual demand quantities in order to determine the activities billing demand. If the actual demand is excessive - if it extends within the premium rate range or approaches it - calculate target demand in accordance with the demand usage factors in Table 2-3. This will serve as a guide for conservation in subsequent target periods. Multiply the total (Table 2-4) by 1.12 for computed target. The target factor, 1.12, accounts for targeted line and transformer losses for that period.

(2) Calculate the targeted monthly cost for purchased electricity by applying to the rate structure billing demand figures and the actual quantities incurred for the remaining variables of the bill.

(3) The unit cost target purchased will equal the target monthly cost divided by the actual utility purchased, line four (4) of Table 2-11.

2.3.2 Produced Unit Cost Target. The produced unit cost target will be obtained by adding the partial cost of production, as obtained on line six (6) of Table 2-12, to the sum of the targeted costs of diesel and steam production which are determined below.

2.3.2.1 Diesel or Gas Turbine Production. For each unit:

(1) Multiply actual kw.-hr. by the factor given in Tables 2-13 for diesel oil or 2-14 for gas to obtain the target consumption. If the B.t.u/gallon of oil or B.t.u./cubic foot for gas differ from 143,190 B.t.u. or 1000 B.t.u., respectively, correct the factor as shown in the Tables.

(2) The targeted cost or costs for fuel consumed are determined by multiplying the targeted quantity or quantities of fuel (diesel or gas) by their respective actual costs in \$ per gallon and/or \$ per M cubic feet. Multiply by 1.007, a factor comprising costs of lube oil and production operation and maintenance material, to obtain the target cost for diesel or gas fuel production.

2.3.2.2 Steam Production. Steam generation at Naval Shore Facilities may be classified under one of four basic types: condensing, extraction-condensing, exhaust, and extraction and exhaust (see Figure 2-2). A few activities use topping turbines. The targeted cost for steam production will be determined as follows:

(1) Non-Condensing Units. For each unit, enter the required data on lines one (1) through eight (8) of Table 2-15. Completion of lines three (3) and six (6) of Table 2-15 will require metered and/or estimated monthly quantities of steam taken from each extraction point and the exhaust point. Where metered values are not available, these quantities should be estimated based on the multi-use steam records of the power plants. The remaining data of Table 2-15 should be obtained by using the manufacturer's design or acceptance test criteria which would prevail for "average loading" conditions on a particular machine. Proceed to the Mollier chart (Figure 3) and determine, as in Example I of Figure 3, the throttle enthalpy, the enthalpy at each extraction, and the exhaust enthalpy by using the pressure-temperature conditions for "average loading", previously obtained in Table 2-15.

(a) Exhaust Units. Calculate the targeted M pounds of steam charged to electrical utility by using the formula on line one (1) of Table 2-17. The targeted cost for exhaust units is determined by multiplying the targeted quantity of M pounds of steam by the actual cost of steam charged to electrical production in \$ per M pounds.

(b) Extraction and Exhaust Units. Calculate the targeted M pounds of steam charged to electrical utility by using the formula on line two (2) of Table 2-17. The targeted cost for extraction and exhaust units is determined by multiplying the targeted quantity of M pounds of steam by the actual cost of steam charged to electrical production in \$ per M pounds.

(2) Condensing Units. For each unit, enter the required data on lines one (1) through seven (7) of Table 2-18. Completion of line four (4) will require metered and/or estimated monthly quantities of steam taken from each extraction point of the turbine. Where meter values are not available, these quantities should be estimated monthly quantities of steam taken from each extraction point of the turbine. Where meter values are not available, these quantities should be estimated based on the multi-use steam utility records of the power plant. The remaining data for lines two (2) through seven (7) should be obtained by using the manufacturer's design or exceptance test criteria which would prevail for "average

loading" conditions on a particular machine.

(a) Straight Condensing Units. Determine the average steam rate of the turbine by using the approximate steam rate curves shown in Figure 2-4. Initial steam conditions, exhaust pressure, size of unit and average loading all affect the determination of this average steam rate. Refer to Figure 2-5 as an indication of the calculation for the average steam rate made, in this manner, for the sample Activity. Calculate the targeted M pounds of steam charged to electric utility by multiplying the average steam rate by the actual energy output of the turbine, from line one (1) of Table 2-17. The targeted cost for straight condensing units is equal to the targeted quantity of M pounds of steam multiplied by the actual cost of steam charged to electrical production in $ per M pounds.

(b) Extraction Condensing Units. Using the Mollier chart (Figure 2-3) determine, as in Example I of Table 2-16, the throttle enthalpy, the enthalpy at each extraction, and, as in Example II of Table 2-16, the exhaust enthalpy. The assumption has been made that the extracted steam does not contain a "significant percent of moisture" as, if it did, its point on the Mollier chart could not be determined unless the moisture content was known. This procedure is relatively difficult and it is recommended that the manufacturer's turbine specifications be referred to when obtaining the moisture percentage. Calculate the targeted M pounds of steam charged to electrical utility by using the formula on line three (3) of Table 2-17. The targeted cost for extraction condensing units is determined by multiplying the targeted quantity of M pounds of steam by the actual cost of steam charged to electrical production in $ per M pounds.

2.3.3 Produced and Purchased Unit Cost Target. The unit cost target produced and purchased will equal the sum of the target dollar costs previously obtained for production and purchases divided by the net utility produced and purchased, line seven (7) of Table 2-11.

2.3.4 Delivered Unit Cost Target.

(1) Compute the partial cost of distribution, as indicated on line five (5) of Table 2-19.

(2) From the appropriate curve of Figure 2-6 select the yearly dollar cost for distribution operation and maintenance material which corresponds to the length of the distribution system in miles which may be obtained from the activities drawings located in the Public Works Office.

(3) The targeted cost for distribution O&M material is determined by multiplying the yearly dollar cost of distribution O&M by the desired month's actual distribution O&M and material cost for the previous year divided by the actual total distribution O&M material cost for the previous year.

(4) The targeted cost for distribution is determined by summing the dollar cost for the partial cost of distribution and the target cost for distribution O&M material.

(5) The unit cost target delivered will equal the sum of the targeted dollar costs for distribution, production and purchases, which have been previously obtained, divided by the net utility delivered, line nine (9) of Table 2-11.

2.3.5 Interpretation of the Unit Cost Target. Comparison of targeted unit cost values versus actual unit costs values provides management with a of weighing the efficiency of a utilities operation by utilizing a method of cost control which is not wholly dependent upon the successful satisfaction of quantity target estimates. As unit costs should not vary, within sensible limits, merely because the quantity of energy distributed differs from the estimate, the limits which must be watched are when significant excess electrical demands force the use of inefficient generation and/or added purchases to meet the higher-than-anticipated requirements.

2.4 SPECIAL ACTIVITIES. Certain activities, notably those servicing ships at piers, those with extensive industrial loads, and those with high intermittent peaks, such as communications stations, do not lend themselves to targeting by applying usage factors. The more common of these are discussed in the paragraphs that follow. In highly special cases, the NAVFAC Engineering Field Division should be consulted for a special target analysis.

2.4.1 Ships. The loads required by ships alongside the dock are the sum of the hotel loads and loads due to special activities, such as testing, battery charging, communications and repair and maintenance work. All ships of the United States Navy log the operating hours of major equipments on board, and this practice, extended if necessary to include equipment brought on board from shoreside to perform special operations, should be used to target special activities. The normal hotel loads are given in Table 2-20. The target is obtained by applying total hours on shore power to obtain kw.-hr. for hotel services, and adding special energy consumption as obtained from the log. An example is given in Table 2-21.

2.4.2 Communications Equipment.

2.4.2.1 Energy Target. Communications transmitting equipment is subject to peak loads that cannot be targeted by use of standard formulae, since they depend on the variable requirements of scheduled and nonscheduled traffic. Further, the number of transmitters on the line and on standby, and their duration in these states, adds to air-conditioning loads and subtracts from heating loads. Conservation is possible with the cooperation of the communications officer in charge and the staff officers responsible for scheduling transmittals, as follows:

(1) By keeping only those transmitters on standby that are required to ensure that genuinely urgent messages will get through. It takes only a few minutes to warm up most transmitters for less urgent messages.

(2) By scheduling routine transmissions so that messages are sent in groups (to avoid starting up and shutting down equipment) and so that, if possible, all messages at a given power and frequency range are sent consecutively over one transmitter.

(3) By ensuring that, when possible, the transmitter with the least power necessary to ensure clear reception will be used. This is by no means a clear-cut proposition, especially with long-range communications at the lower end of the frequency spectrum (HF to LF), which is subject to atmospheric interference and variable skip distances. But it should be possible, with planning, to avoid the situation where 10 kw. transmitters are used when 1 kw. would suffice, because too many transmissions are being attempted simultaneously in the 1 kw. range.

To calculate target data, the following information is required:

(1) Rating of transmitters (and other major items of equipment) in kw.

(2) Standby power requirements (from manufacturer's handbooks or specifications).

(3) Heat dissipated.

NOTES: If B.t.u. of heat dissipation is not given in manufacturer's data, assume that standby power (in watts) = heat dissipated, since essentially all the standby power is used in keeping the system warmed up.

In calculating total quantities of heat dissipated by each equipment, subtract the heat removed by any special equipment cooling system that discharges heat outside the building.

(4) Number of scheduled transmissions per day, and total actual transmitting time in target period at each required power unit, obtained from log of communications station. Transmitting time may also be determined by number of messages and average transmitting time (obtained by a sample time study over a two- or three-day period). The target data should be based on the required power level, not the actual level, in cases where an excessively high-powered antenna was used.

(5) Standby requirements. This would normally be one transmitter on standby in each frequency/power category reserved for emergency transmissions, plus others as established by fleet directives.

EXAMPLE (see Table 2-7):

A shore-to-ship transmitting station has 19 transmitters, 10 at 1 kw., 4 each at 4 and 10 kw., and 1 at 100 kw. The transmission energy is targeted by multiplying the transmitting time at each power rating (which may be obtained as shown in Table 2-8) by the rating and adding a factor for warmup and time energized between transmissions.

Standby energy is targeted by assuming that one transmitter in vital communications networks is on standby at all times. Add to this additional standby transmitters as demanded by directives and fleet requirements.

The standby target energy can then be calculated by multiplying standby hours by rated standby power. Total target energy requirements are obtained by adding transmitting and standby target energies. Apply these as special loads to the energy target for the feeder or activity (see paragraph 2.2.3(4).

NOTE: Where transmissions are initiated remotely, it will be necessary to either log transmissions in each power category at the remote station or use electronic timing devices at the transmitting station.

2.4.2.2 <u>Demand</u>. The demand picture at a communications station is dominated by the requirements (including air conditioning) of the major transmitting units. A typical load distribution might be:

| | |
|---|---|
| Communications Equipment | 190 kva. |
| Mechanical Ventilation and Pumping | 6 kva. |
| Air Conditioning | 77 kva. |
| Lighting and Miscellaneous | 10 kva. |
| | 283 kva. |
| with a maximum at 90% demand factor of | 255 kva. |

If demand is a critical item, because of premium demand charges or the threat of overloads and brown-outs, demand can be targeted in terms of maximum number of transmitters operating simultaneously.

In the example in Table 2-7, the 100 kw. transmitter is the limiting element. Assume premium rates start at 200 kw.:

| | |
|---|---|
| Transmitter | 100 kw. |
| Air Conditioning | 77 kw. |
| Miscellaneous | 16 kw. |
| | 193 kw. |

Thus, to allow a margin, the target can be expressed simply as "no other transmitters operating when 100 kw. transmitter is operating." When there is no dominant high-powered LF transmitter, demand can be developed, for example, in terms of transmitters on the line, starting with the highest powered or most numerous:

| No. of 10 kw transmitters operating | Max. 4 kw | Max. 1 kw |
|---|---|---|
| 4 | 0 | 4 |
| | 1 | 0 |
| 3 | 2 | 0 |
| | 1 | 4 |

2.4.3. Computers. Computer loads are relatively high, but they are steady and easily targeted. Normally a computer is on line at all times, except for minimal downtime for maintenance and repair, or for one or two shifts each day. Since the computer uses little more power when it is operating than when it is on the line but idle, the hours energized can be used for targeting purposes. It is important that downtime be logged, especially in cases where the computer is out of commission for several hours or more due to a failure. Computer load targets are calculated by multiplying on-line hours by rated load. Apply them as special loads to the distribution target.

2.4.4 Heating and Air Conditioning, Electronic Equipment. Communications equipment, computers, and some other types of electronic equipment give off great quantities of heat, which will greatly increase air conditioning loads in the summer but will also contribute substantial savings in heating during the winter. If direct data on heat dissipation are not available for communications equipment, the heating load can be assumed to be the same as the rated standby load (in kw.), since the purpose of standby power is to keep the filaments and other heating elements warmed up. This rated standby load is used for heat dissipation calculations when the equipment is in use, as well as on standby.

Clearly, heat removed from electronic equipment will be recirculated within the building during the heating season, assuming the system is properly designed and managed. Therefore, the target should be calculated on this basis even if, in fact, there are not now provisions for recirculating. In such a case, the target value can be compared with actual heating loads to obtain a close dollar prediction of savings that can be realized by installing recirculating ducts and/or fans. See Table 2-10 for sample heat load calculations for communications, computers, and other equipment.

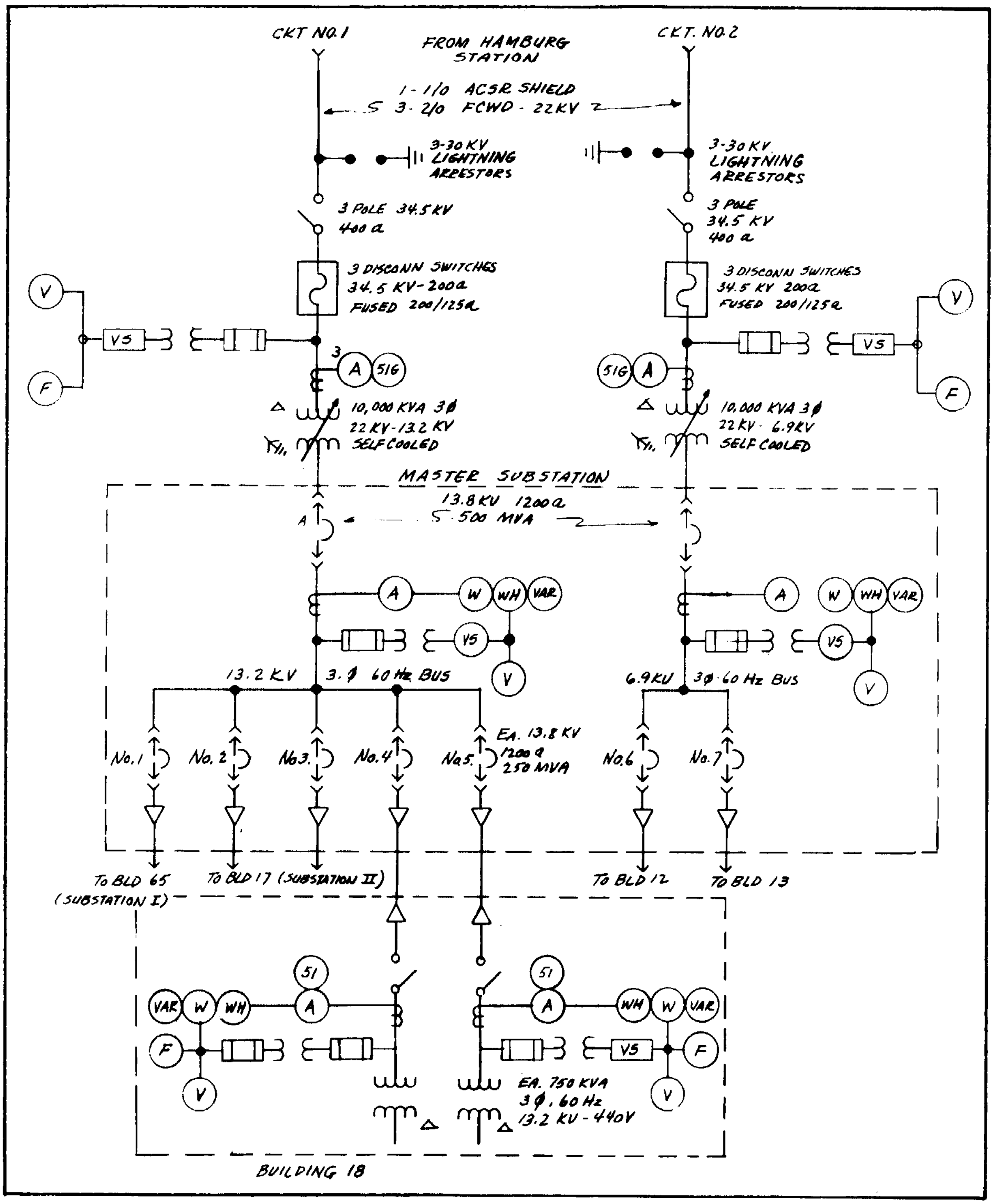



FIGURE 2-1 (1 of 2)
One Line Diagram - Primary Distribution

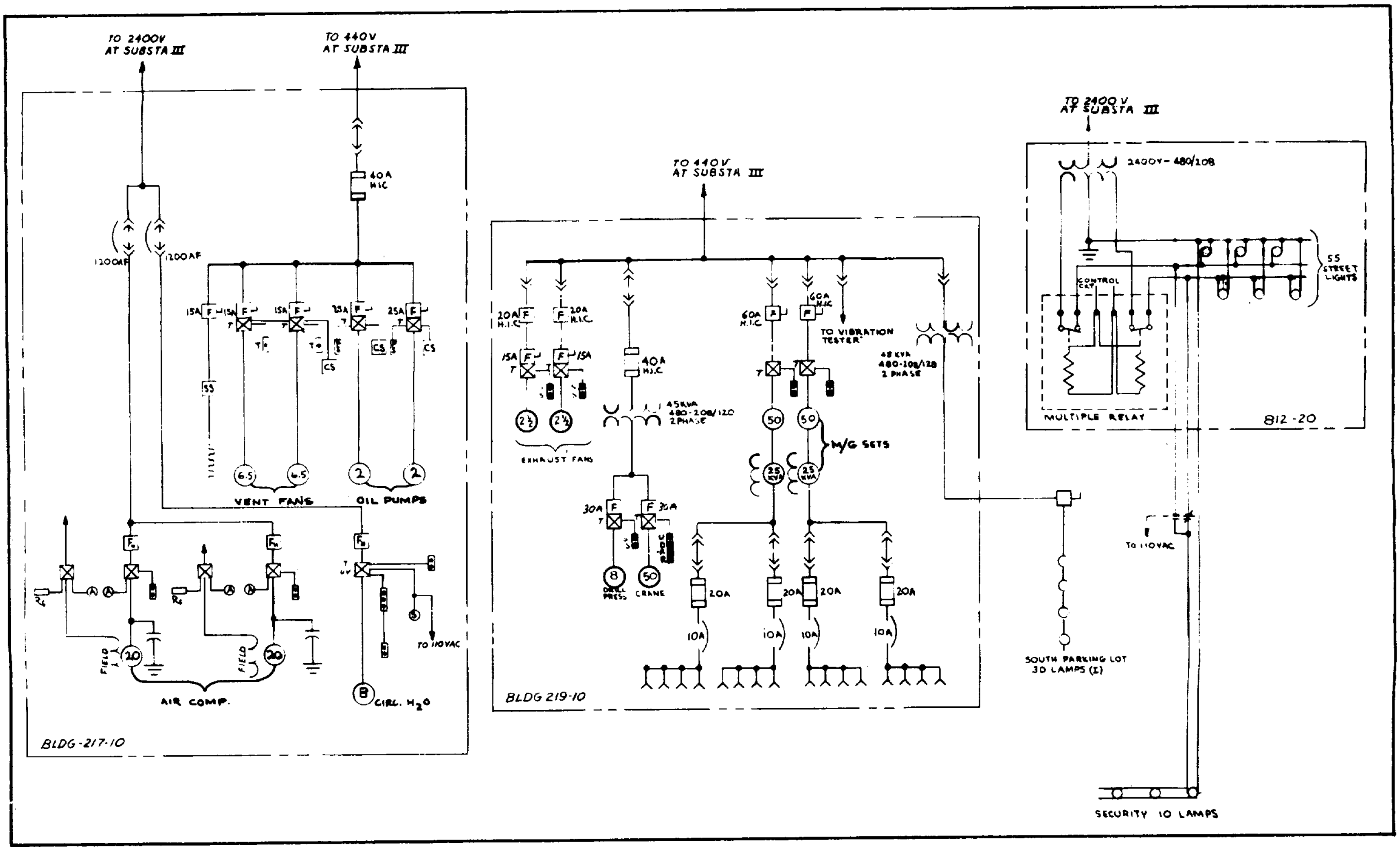



FIGURE 2-1 (2 of 2)
One Line Diagram - Secondary Feeders

TABLE 2-1 (1 of 3)
Detailed Inventory of Naval Shore Facilities
PART I - Property

| Cross-Reference Index | | General Data | | |
|---|---|---|---|---|
| Bldg. or Struc. No. | Category Code | Name of Installation | Location of Installation | |
| 1 | 610-10' | Principal Function or Product | | |
| 2 | 171-20 | | | |
| 3 | 219-10 | | | |
| | 610-10 | Structures and Utilities Summary | | |
| | 610-90 | | | |
| 4 | 442-10 | | | |
| 5 | 520-10 | | | |
| 6 | 721-10 | | | |
| 7 | 721-10 | | | |
| 8 | 721-20 | Building Summary | | |
| 9 | 216-10 | | | |
| 10 | 310-20 | | | |
| 11 | 218-20 | | | |
| | 219-90 | | | |
| H-1 | 711-11 | Land Summary (Acres) | Grounds (Acres) | Plant Value $ Dollars |
| H-2 | 711-11 | | | |
| H-3 | 711-11 | | | |
| M4 | 125-50 | Component/Tenant Activities (A) Noncontiguous Areas (N) | | |
| T26 | 310-90 | Tenant 1 /A/ | | |
| T28 | 610-10 | Tenant 2 /N/ | | |
| | | Tenant 3 /A/ | | |

TABLE 2-1 (2 of 3)
Detailed Inventory of Naval Shore Facilities
PART II - Real Property Detail

| | | Name of Installation | Location of Installation | | |
|---|---|---|---|---|---|
| Category | | | Area Total | | Build Struc. Number |
| Code | Description/Local | | | | |
| 124-30 | Stor. Tanks | | | | |
| 124-30 | Tank Jet Juel | | | | |
| * | Category Total | | | | |
| 132-10 | Antenna-Trans. | | | | |
| 132-10 | Antenna-Bldg 2 | | | | |
| * | Category Total | | | | |
| 136-30 | Runway Lighting | | | | |
| * | Category Total | | | | |
| 151-20 | Concrete Pier 1 | | 11735 SY | | |
| 151-30 | Concrete Pier 2 | | 6540 SY | | |
| * | Category Total | | 18275 SY | | |
| 171-20 | Appl. Inst. Bldg | | 2240 SF | | 2 |
| * | Category Total | | 2240 SF | | |
| 216-10 | Ammo Rework Shop | | 3400 SF | | 9 |
| * | Category Total | | 3400 SF | | |
| 218-20 | Const. Equip. Main. Shop | | 10000 SF | | 11 |
| * | Category Total | | 10000 SF | | |
| 219-10 | P.W. Main. Shop | | 8500 SF | | 3 |
| 219-90 | Misc. Productions | | 5000 SF | | 11 |
| * | Category Total | | 13500 SF | | |
| 442-10 | Warehouse | | 13250 SF | | 4 |
| * | Category Total | | 13250 SF | | |
| 520-10 | Hospital | | 6135 SF | | 5 |
| * | Category Total | | 6135 SF | | |
| 610-10 | Admin. Bldg | | 4650 SF | | 1 |
| 610-10 | Admin. Bldg | | 5200 SF | | 3 |
| 610-90 | Admin. Other | | 647 SF | | 3 |
| * | Category Total | | 10497 SF | | |

# Detailed Inventory of Naval Shore Facilities
## PART II - Real Property Detail

| Continued | Name of Installation | | Location of Installation | | |
|---|---|---|---|---|---|
| Category | | | Area Total | | Build Struc. Number |
| Code | Description/Local | | | | |
| 711-11 | Quarters | | 1690 SF | | H-1 |
| 711-11 | Quarters | | 1565 SF | | H-2 |
| 711-11 | Quarters | | 1390 SF | | H-3 |
| * | Category Total | | 4645 SF | | |
| 721-10 | Barracks EM | | 2158 SF | | 6 |
| 721-10 | Barracks EM | | 2158 SF | | 7 |
| 721-20 | Barracks EW | | 1401 SF | | 8 |
| * | Category Total | | 5717 SF | | |
| 812-20 | Street Lighting | | | | |
| 812-50 | Flood Lighting | | | | |
| 812-50 | Flood Lighting | | | | |
| * | Category Total | | | | |
| Tenant "1" | | | | | |
| 310-20 | Chem. Lab. | | 1863 SF | | 10 |
| * | Category Total | | 1863 SF | | |
| Tenant "2" | | | | | |
| 310-90 | Rocket Test Bldg | | 236 SF | | T26 |
| * | Category Total | | 236 SF | | |
| 610-10 | Admin. Bldg | | 104 SF | | T28 |
| * | Category Total | | 104 SF | | |
| Tenant "3" | | | | | |
| 124-90 | Gas Storage Tank | | | | |
| * | Category Total | | | | |
| 125-45 | Pumping Station | | 320 SF | | M-4 |
| * | Category Total | | 320 SF | | |

TABLE 2-2
DOD Property Record

| DOD Property Record | | | Name of Item: SAW |
|---|---|---|---|

SECTION I – INVENTORY CODES

8. Present Location

Bldg. 3

SECTION II – INVENTORY DATA

18. Description and Capacity: Saw – Electric Motor Driven

SECTION III – ACQUISITION AND TRANSFER

SECTION IV – DISPOSITIONAL DATA

42. SECTION V – ELECTRICAL CHARACTERISTICS

| Quantity | Horse-Power | Volts | Phase | Cycle | AC | DC | |
|---|---|---|---|---|---|---|---|
| 1 | 5 | 220 | 1 | 60 | X | | |

DD Form 1342
1 Mar 61

## TABLE 2-3 (1 of 3)
## Usage Factors for Energy and Demand Calculations

| Navy Code | Usage Factor For Energy | | Usage Factor For Demand | |
|---|---|---|---|---|
| | Area | Load | Area | Load |
| 121-All | .21 | .09 | .64 | .28 |
| 122-All | .21 | .09 | .64 | .28 |
| 123-All | .22 | .08 | .73 | .26 |
| 125-All | .28 | .12 | .94 | .41 |
| 126-All | .02 | .03 | .07 | .11 |
| 131-40 | .99 | .33 | 1.32 | .44 |
| 131-Other | 1.38 | .46 | 1.50 | .50 |
| 133-40 | .29 | .15 | .74 | .39 |
| 133-70 | 1.38 | .46 | 1.47 | .49 |
| 133-Other | .87 | .46 | .95 | .50 |
| 141-10 | .42 | .22 | .82 | .43 |
| 141-20 | .12 | .05 | .25 | .11 |
| 141-30 | .32 | .19 | .82 | .48 |
| 141-40 | .55 | .22 | 1.08 | .43 |
| 141-60 | .30 | .13 | .94 | .41 |
| 141-Other | .27 | .16 | .71 | .42 |
| 159-All | .15 | .08 | .40 | .21 |
| 171-10 | .24 | .12 | .64 | .32 |
| 171-20 | .25 | .12 | .61 | .29 |
| 171-30 | .11 | .14 | .36 | .45 |
| 171-40 | .08 | .04 | .32 | .17 |
| 171-Other | .12 | .07 | .39 | .23 |
| 211-10 | .53 | .14 | .12 | .32 |
| 211-30 | .68 | .18 | 1.75 | .46 |
| 211-40 | .26 | .08 | .73 | .22 |
| 211-50 | .57 | .13 | 1.32 | .30 |
| 211-60 | .26 | .08 | .73 | .22 |
| 211-70 | .26 | .08 | .73 | .22 |
| 211-Other | .13 | .08 | .40 | .25 |
| 212-All | .20 | .07 | .59 | .21 |
| 213-30 | .18 | .08 | .46 | .21 |
| 213-Other | .52 | .20 | 1.22 | .47 |
| 214-All | .52 | .14 | 1.37 | .37 |
| 215-All | .48 | .17 | 1.32 | .47 |
| 216-10 | .22 | .08 | .62 | .22 |
| 216-20 | .22 | .08 | .62 | .22 |
| 216-30 | .20 | .07 | .59 | .21 |
| 216-40 | .12 | .10 | .37 | .31 |
| 216-50 | .22 | .08 | .62 | .22 |
| 216-60 | .43 | .14 | 1.19 | .38 |
| 216-Other | .39 | .14 | 1.06 | .38 |
| 217-All | .23 | .09 | .60 | .24 |
| 218-10 | .37 | .16 | .94 | .41 |
| 218-20 | .25 | .09 | .70 | .25 |
| 218-40 | .15 | .07 | .46 | .22 |
| 218-50 | .31 | .14 | .81 | .37 |
| 218-Other | .27 | .15 | .68 | .38 |
| 219-10 | .19 | .07 | .57 | .21 |
| 219-Other | .09 | .05 | .31 | .18 |
| 221-All | .26 | .08 | .73 | .22 |
| 222-All | .20 | .07 | .59 | .21 |
| 223-All | .11 | .07 | .26 | .17 |
| 225-30 | .12 | .05 | .29 | .12 |
| 225-Other | .17 | .05 | .41 | .12 |
| 226-10 | .48 | .17 | 1.18 | .42 |
| 226-15 | .28 | .10 | .70 | .25 |
| 226-20 | .22 | .08 | .62 | .22 |
| 226-35 | .22 | .08 | .62 | .22 |
| 226-40 | .22 | .08 | .62 | .22 |
| 226-55 | .22 | .08 | .62 | .22 |
| 226-65 | .22 | .08 | .62 | .22 |
| 226-Other | .23 | .10 | .62 | .27 |
| 227-10 | .35 | .14 | .88 | .35 |
| 227-20 | .35 | .14 | .88 | .35 |
| 227-40 | .35 | .14 | .88 | .35 |
| 227-Other | .66 | .20 | 1.65 | .50 |
| 228-10 | .29 | .09 | .77 | .24 |
| 228-Other | .66 | .20 | 1.65 | .50 |
| 229-10 | .10 | .08 | .39 | .30 |
| 229-20 | .18 | .14 | .57 | .44 |
| 229-30 | .18 | .14 | .57 | .44 |
| 229-40 | .08 | .09 | .24 | .27 |
| 229-Other | .42 | .13 | 1.02 | .32 |
| 310-20 | .46 | .19 | .98 | .41 |
| 310-30 | .03 | .01 | .10 | .04 |
| 310-44 | .43 | .10 | .86 | .20 |
| 310-58 | .46 | .19 | .98 | .41 |
| 310-68 | .12 | .07 | .27 | .16 |

TABLE 2-3 (2 of 3)
Usage Factors for Energy and Demand Calculations

| Navy Code | Usage Factor For Energy | | Usage Factor For Demand | |
|---|---|---|---|---|
| | Area | Load | Area | Load |
| 310-Other | .22 | .10 | .51 | .23 |
| 421-All | .16 | .18 | .43 | .48 |
| 422-All | .16 | .18 | .43 | .48 |
| 423-All | .16 | .18 | .43 | .48 |
| 431-All | .15 | .17 | .41 | .45 |
| 432-All | .20 | .22 | .41 | .46 |
| 441-20 | .16 | .23 | .32 | .45 |
| 441-30 | .13 | .18 | .34 | .48 |
| 441-40 | .13 | .18 | .31 | .44 |
| 441-Other | .12 | .20 | .31 | .51 |
| 442-10 | .24 | .16 | .60 | .40 |
| 442-20 | .32 | .19 | .83 | .49 |
| 442-30 | .27 | .16 | .68 | .40 |
| 442-40 | .27 | .16 | .68 | .40 |
| 442-50 | .20 | .13 | .57 | .38 |
| 442-60 | .24 | .16 | .60 | .40 |
| 442-Other | .27 | .18 | .72 | .48 |
| 510-All | .26 | .20 | .54 | .27 |
| 520-All | .38 | .21 | .50 | .28 |
| 530-10 | .30 | .08 | .70 | .19 |
| 530-20 | .20 | .08 | .48 | .19 |
| 530-Other | .45 | .18 | 1.03 | .41 |
| 540-All | .26 | .08 | .61 | .19 |
| 550-All | .23 | .11 | .53 | .25 |
| 610-All | .45 | .16 | 1.09 | .39 |
| 620-All | .74 | .23 | 1.34 | .42 |
| 690-All | .17 | .10 | .61 | .36 |
| 711-All | .09 | .09 | .22 | .22 |
| 712-All | .10 | .10 | .25 | .25 |
| 714-All | .01 | .01 | .02 | .04 |
| 721-20 | .34 | .14 | .53 | .22 |
| 721-Other | .35 | .15 | .58 | .25 |
| 722-20 | .26 | .16 | .56 | .35 |
| 722-Other | .22 | .16 | .50 | .36 |
| 723-10 | .65 | .18 | .83 | .23 |
| 723-20 | .25 | .18 | .57 | .41 |
| 723-30 | .21 | .08 | .55 | .21 |
| 723-Other | .01 | .01 | .02 | .04 |
| 724-30 | .31 | .13 | .58 | .24 |
| 724-Other | .18 | .10 | .43 | .24 |
| 730-10 | .07 | .05 | .14 | .11 |
| 730-15 | .32 | .23 | .56 | .40 |
| 730-20 | .26 | .12 | .59 | .27 |
| 730-30 | .48 | .23 | .92 | .44 |
| 730-35 | .65 | .18 | .86 | .24 |
| 730-40 | .13 | .16 | .31 | .39 |
| 730-45 | .21 | .08 | .55 | .21 |
| 730-50 | .17 | .10 | .61 | .36 |
| 730-55 | .18 | .10 | .65 | .36 |
| 730-60 | .19 | .10 | .67 | .35 |
| 730-65 | .46 | .27 | .88 | .52 |
| 730-70 | .24 | .14 | .58 | .34 |
| 730-Other | .20 | .14 | .48 | .34 |
| 740-10 | .09 | .10 | .23 | .26 |
| 740-14 | .40 | .18 | .92 | .42 |
| 740-18 | .49 | .18 | 1.30 | .48 |
| 740-23 | .35 | .16 | .86 | .39 |
| 740-26 | .16 | .12 | .46 | .35 |
| 740-30 | .25 | .09 | .78 | .28 |
| 740-33 | .56 | .18 | 1.49 | .48 |
| 740-36 | .29 | .08 | .68 | .19 |
| 740-40 | .17 | .10 | .43 | .25 |
| 740-43 | .41 | .24 | .77 | .45 |
| 740-46 | .17 | .10 | .43 | .25 |
| 740-50 | .18 | .08 | .46 | .20 |
| 740-53 | .37 | .22 | .65 | .38 |
| 740-54 | .30 | .16 | .70 | .37 |
| 740-56 | .90 | .06 | 2.25 | .15 |
| 740-60 | .27 | .10 | .70 | .26 |
| 740-63 | .34 | .12 | .81 | .29 |
| 740-66 | .34 | .12 | .81 | .29 |
| 740-70 | .27 | .10 | .70 | .26 |
| 740-73 | .44 | .26 | .82 | .48 |
| 740-76 | .44 | .26 | .82 | .48 |
| 740-80 | .11 | .14 | .27 | .34 |
| 740-83 | .46 | .27 | .88 | .52 |
| 740-86 | .22 | .16 | .56 | .40 |
| 740-88 | .36 | .24 | .77 | .51 |
| 740-Other | .08 | .07 | .23 | .19 |
| 750-All | .08 | .19 | .18 | .44 |
| 811-20 | .56 | .35 | .67 | .42 |
| 811-60 | .07 | .06 | .20 | .17 |
| 811-Other | .61 | .38 | .72 | .45 |
| 821-10 | .35 | .22 | .51 | .32 |
| 821-20 | .42 | .26 | .62 | .39 |
| 821-30 | .42 | .26 | .62 | .39 |

## TABLE 2-3 (3 of 3)
## Usage Factors for Energy and Demand Calculations

### EXHIBIT 2-4 (3)

| Navy Code | Usage Factor For Energy | | Usage Factor For Demand | | Navy Code | Usage Factor For Energy | | Usage Factor For Demand | |
|---|---|---|---|---|---|---|---|---|---|
| | Area | Load | Area | Load | | Area | Load | Area | Load |
| 821-50 | .30 | .19 | .54 | .34 | 890-40 | .18 | .18 | .44 | .44 |
| 821-Other | .25 | .19 | .44 | .34 | 890-Other | .17 | .19 | .41 | .46 |
| 831-All | .10 | .12 | .23 | .29 | | | | | |
| 832-All | .15 | .19 | .29 | .36 | Street Lighting | – | .44 | – | – |
| 833-10 | .09 | .10 | .29 | .32 | | | | | |
| 833-50 | .04 | .18 | .10 | .48 | | | | | |
| 833-Other | .15 | .07 | .46 | .21 | Security Lighting | – | .44 | – | – |
| 841-All | .27 | .14 | .79 | .41 | | | | | |
| 842-20 | .18 | .14 | .53 | .41 | | | | | |
| 842-Other | .02 | .08 | .09 | .29 | Airfield Lighting | – | .21 | – | – |
| 890-20 | .14 | .14 | .37 | .37 | | | | | |

Note: For Navy Codes where double shift operations occur; the usage factors for energy area & load should be multiplied by 1.28. Caution: Do not use where less than 16 hours operation occur.

TABLE 2-4
Normal Connected Load

| FEEDER #1 | | | | | | | |
|---|---|---|---|---|---|---|---|
| BUILDING | CODE | AREA (X1000 SF) | PRINCIPAL CONN. LOADS (2 kw-hr) | USAGE FACTORS | | TARGETS | |
| | | | | DEMAND | ENERGY | DEMAND | ENERGY |
| 28-PUBLIC WORKS | 219-10 | 21.06 | | .57 | .19 | 12.0 | 4.0 |
| AIR COMPRESSORS (2) at 20 kw | | | 40 kw | .21 | .07 | 8.40 | 2.80 |
| MOTOR VENT FANS (2) at 6.5 | | | 13 | .21 | .07 | 2.70 | 0.91 |
| Oil Pumps (2) at 2 | | | 4 | .21 | .07 | 0.84 | 0.28 |
| Circulating Water | | | 8 | .21 | .07 | 1.68 | 0.56 |
| 31-MAINTENANCE SHOP | 217-10 | 9.00 | | .60 | .23 | 5.40 | 2.07 |
| EXHAUST FANS (2) at 2.5 | | | 5 | .24 | .09 | 1.20 | 0.45 |
| DRILL PRESS | | | 8 | .24 | .09 | 1.92 | 0.72 |
| CRANE | | | 50 | .24 | .09 | 12.00 | 4.50 |
| MG SETS (2) at 50 | | | 100 | .24 | .09 | 24.00 | 9.00 |
| VIBRATION TESTER | | | (see special loads) | | | | |
| | | | | | | 70.14 kw | 25.29 kw |

TABLE 2-5
Special Loads

| | RATING (KW) | HRS OPERATION[1] | KWH | KW DEMAND |
|---|---|---|---|---|
| VIBRATION TESTER | 60 | 4.5 | 270 | 60 |
| PUMPS, DRY DOCK NO. 2 (4 at 80) | 320 | 8.0 | 2560 | 2560 |
| TOTAL | | | 2830 | 2560[2] |

[1]Total hours operation during target period - one month.

[2]Assume operations planned to avoid simultaneous operation of pumps and special test equipment.

TABLE 2-6
Outdoor Lighting - Feeder No. 2

| No. of Lamps (1) | Rating Watts (2) | Total (kw) (3) | Avg. Hrs/Day Period (4) | Avg. Hrs/Day Hours (5) | Number of Days Total in Period (6) | Number of Days Excluded (7) | Number of Days Total Operating (8) | Total Hrs in Period (5) X (8) | Target Kw-hr (3) X (9) |
|---|---|---|---|---|---|---|---|---|---|
| South Parking Lot | | | | | | | | | |
| 30 | 600 | 18 | Sunset/ 12M | 6.5 | 30 | 9 (Sat., Sun., Hol.) | 21 | 137 | 2466 |
| Street - Sector No. 2 | | | | | | | | | |
| 55 | 550 | 30 | Sunset/ Sunrise | 13 | 30 | - | 30 | 390 | 11700 |
| Security - Missile Storage | | | | | | | | | |
| 10 | 400 | 4 | Sunset/ Sunrise | 13 | 30 | - | 30 | 390 | 1560 |
| TOTAL TARGET KW-HR | | | | | | | | | 15726 |

TABLE 2-7 (1 of 2)
Summary Calculations (For 30-Day Period) - Feeder #1

| | | | | |
|---|---|---|---|---|
| I. ENERGY TARGET | | | | |
| SERVICE & NORMAL CONNECTED LOADS (Table 2-4) | | | | |
| AVE. POWER | | 25 kw | | |
| No. of Hrs. In Period | x | 720 | | |
| TARGET kw-hr | | | 18,000 kw-hr | (1) |
| SPECIAL LOADS (Table 2-5) | | | 2,830 kw-hr | (2) |
| OUTDOOR LIGHTING (Table 2-6) | | | 15,726 kw-hr | (3) |
| ELECTRIC HEATING | | | | |
| BTU (See Chapter 4, Table 4-2, Item 1) | | $32 \times 10^{6}$ | | |
| Conversion factor | x | $293 \times 10^{-6}$ | | |
| | | | 9,376 kw-hr | (4) |
| TOTAL (1) thru (4) | | | 45,932 | (5) |
| LINE & TRANSFORMER - LOSSES 6% of (5) or calculated | | | 2,756 | |
| TARGET kw-hr | | | 48,688 kw-hr | |

TABLE 2-7 (2 of 2)
Summary Calculations (For 30-Day Period) - Feeder #1

| | | |
|---|---|---|
| **II. DEMAND TARGET** | | |
| SERVICE & NORMAL CONNECTED LOADS (Table 2-4) | 64 kw | (1) |
| SPECIAL LOADS (Table 2-5) | | |
| Vibration Tester | 60 kw | (2) |
| NOTE: Assume Dry Dock Pumps are run during offpeak hours, per Activity Conservation policies. | | |
| OUTDOOR LIGHTING (Table 2-6) | 42 kw | (3) |
| ELECTRIC HEATING, from DD1342, Property Record Card | 38 kw | (4) |
| NOTE: Use full rated or metered capacity, if full plant cycles on even during periods of limited BTU consumption. | | |
| TOTAL, (1) thru (4) | 204 kw | (5) |
| LINE & TRANSFORMER LOSSES (0.12 × (5) or calculated) | 24 kw | |
| TARGET DEMAND | 228 kw | |

TABLE 2-8
Sample Calculation for Communication Station

1. Transmitters

| No. | Rating, Operational (kw) | Standby (kw) | Remarks |
|---|---|---|---|
| 10 | 1 | 0.12 | |
| 4 | 4 | 0.9 | |
| 4 | 10 | 2.6 | |
| 1 | 100 | 5.8 | Liquid cooling, capac. $150 \times 10^{-6}$ Btu/hr (=4.4 kw) |

2. Number on Standby

Full time one 1 kw
one 10 kw
Fleet maneuvers, Jan. 15 - Jan. 28 = 13 days
one 4 kw

3. Target Energy Consumption

(a) Transmitting Time (Table 2-9)

| | | kw-hr |
|---|---|---|
| 1 kw: | 236 hr | 236 |
| 4 kw: | 122 hr | 488 |
| 10 kw: | 58 hr | 580 |
| 100 kw: | 36 hr | 3600 |
| | | 4904 kw-hr total |

(b) Standby

| | | | | |
|---|---|---|---|---|
| 0.12 kw (standby power) | × 30 days | × 24 hr | = | 86 kw-hr |
| 1.1 kw | × 30 " | × " | = | 792 |
| 0.9 kw | × 13 " | × " | = | 281 |
| Total | | | | 1159 kw-hr |

(c) Totals

| | |
|---|---|
| Transmission (total 3a) | 4904 |
| 10% for warmup and time between transmissions | 490 |
| Standby (total 3b) | 1159 |
| Energy Target | 6553 kw-hr |

TABLE 2-9
Sample Calculation for Transmitting Time

| Transmissions, 10 kw January 15 | | Time (minutes) (Logged by Operator) |
|---|---|---|
| 0900 | | 5.2 |
| 0906 | | 3.2 |
| 0910 | | 10.8 |
| 0915 | | 7.2 |
| 1220 | | 3.7 |
| 1224 | | 9.2 |
| 1233 | | 11.2 |
| 1612 | | 7.9 |
| 1621 | | 8.2 |
| 1631 | | 9.8 |
| 1642 | | 8.2 |
| 11 messages | | 84.6 minutes |
| Messages | | Minutes |
| 22 (Jan. 16) | (Calculated as for | 178.2 |
| 19 (Jan. 17) | Jan. 15, above) | 138.7 |
| Totals 52 | | 401.5 |

Average $\frac{401.5}{52}$ = 7.72 minutes/messages

Total for Month: $\frac{452 \text{ messages} \times 7.72}{60}$ minutes/messages = 58.2 hours

TABLE 2-10
Special Equipment Heating/Air Conditioning

<u>Communications Equipment</u>

1. Standby Energy Consumption (Table 2-8, 3-b). 1159 kw-hr

2. Total Transmitting Heat (Table 2-8, 3-a).

| | | |
|---|---|---|
| 1 kw trans.: 236 hr x 0.12 kw (use standby power rating to calculate heat if Btu output is not available - see Table 2-8 par.1) | 28 | kw-hr |
| 4 kw trans.: 122 hr x 0.9 kw | 110 | |
| 10 kw trans.: 58 hr x 2.6 kw | 151 | |
| 100 kw trans.: 36 hr x 5.8 kw | 209 | |
| Subtotal | 498 | kw-hr |
| Less heat removed by liquid cooling (Table 2-8 par. 1): 36 hr x 4.4 kw | 158 | |
| | 340 | |
| Add 10% for warmup and time between transmissions | 34 | |
| Target Heat Production | 374 | kw-hr |

$$\frac{374 \text{ kw-hr}}{0.000293 \text{ kw-hr/Btu}} = 1.27 \times 10^6 \text{ Btu}$$

3. Application.

Add this heat to the total air conditioning load (Chapter 5) or subtract from total heating load (Chapter 4 or par. 2.2.3).

<u>Computers and Other Heat-Producing Electronic Equipment</u>

Computers: Rated Btu/hr x hours on line.
Transformers (inside building): Rated Btu/hr x hours energized less heat dissipated externally by convection cooling system.

NOTE: For target purposes, assume that in the heating season heat from computers, internal transformers, and similar equipment is dissipated internally in building, since good practice demands that equipment heat removal systems provide for internal re-circulation to reduce heating system loads.

Other: See manufacturer's specifications.

Add equipment heat to air conditioning load (Chapter 5) or subtract from heating load (Chapter 4 or par. 2.2.3).

TABLE 2-11
Quantity Monthly Inventory[1]

| | MKWH |
|---|---|
| (1) Gross Plant Production (actual) | 75 |
| (2) Quantities Used in Production (actual) | 12 |
| (3) Net Plant Production ((1)-(2)) | 63 |
| (4) Purchased Utilities (actual) | 90 |
| (5) Total Production and Purchases = ((3)+(4)) | 153 |
| (6) Interutility Transfers (actual) | 21 |
| (7) Net Utilities Produced and Purchased = ((5)-(6)) | 132 |
| (8) Quantities Lost in Distribution (actual) | 8 |
| (9) Net Utility Delivered = ((7)-(8)) | 124 |

[1]Refer to lines one (1) through eight (8) on NavCompt Form 2127 for this information.
Note: lines above do not necessarily correspond to the lines on the NavCompt Form 2127.

TABLE 2-12
Monthly Partial Cost of Production[1]

| | |
|---|---|
| (1) Operation and Maintenance Labor Cost (actual) | $ 1,340 |
| (2) Operation and Maintenance Contractual and Other Costs (actual) | 310 |
| (3) Apportioned General Plant Expense (actual) | 0 |
| (4) General Expense Applied (NIF) (actual) | 0 |
| (5) Cost Attributed to Electrical Interutility Transfer (actual) | 1,171 |
| (6) Partial Cost of Production = ((1)+(2)+(3)+(4)-(5)) | 479 |

[1]Refer to lines sixteen (16) through twenty-seven (27) on NavCompt Form 2127 for this information.

TABLE 2-13
Monthly Targeted Diesel Fuel Consumption

| | |
|---|---|
| (1) Fuel Consumption Factor (see table below) | 0.0703 |
| (2) Diesel Oil Weight (pound per gallon) (actual) | 7.4 |
| (3) Heating Value (Btu per pound) (actual) | 20,120 |
| (4) Btu Content per Gallon = ((2) ×(3)) | 148,888 |
| (5) Constant = (143,190 Btu per gallon) | 143,190 |
| (6) Correction Factor = ((5) ÷ (4)) | 0.96 |
| (7) Corrected Fuel Consumption Factor (gallon per KW-HR) = ((1)×(6)) | 0.0675 |
| (8) Total KW-HR Produced of Unit (actual) | 25,000 |
| (9) Target Fuel Consumption (gallons) = ((7)×(8)) | 1,688 |

| Slow Speed (600 RPM & Under) | | | High Speed (601 RPM & Above) | | |
|---|---|---|---|---|---|
| KW Rating | Gallons per KW-HR | | KW Rating | Gallons per KW-HR | |
| | Below 1/2 Load | 1/2 Load & Above | | Below 1/2 Load | 1/2 Load & Above |
| 0 - 200 | - | - | 0 - 200 | 0.0797 | 0.0757 |
| 201 - 500 | - | - | 201 - 500 | 0.0757 | 0.0716 |
| 501 - 1,000 | 0.0757 | 0.0716 | 501 - 1,000 | 0.0757 | 0.0716 |
| 1,001 - 1,500 | 0.0743 | 0.0709 | 1,001 - 1,500 | 0.0757 | 0.0716 |
| 1,501 - 2,500 | 0.0730 | 0.0703 | 1,501 - 2,500 | - | - |
| 2,501 & over | 0.0730 | 0.0703 | 2,501 & over | - | - |

TABLE 2-14
Monthly Targeted Gas Fuel Consumption

EXHIBIT 2-15

MONTHLY TARGETED GAS FUEL CONSUMPTION

| | |
|---|---|
| (1) Fuel Consumption Factor (see table below) | 0.0106 |
| (2) Btu Content (Btu per C.F.) (actual) | 950 |
| (3) Constant (1,000 Btu per C.F.) | 1,000 |
| (4) Correction Factor = ((3) ÷ (2)) | 1.05 |
| (5) Corrected Fuel Consumption Factor (MCF per KW-HR) = ((1)x(4)) | 0.0111 |
| (6) Total KW-HR Produced of Unit (actual) | 25,000 |
| (7) Targeted Fuel Consumption (MCF) = ((5) × (6)) | 278 |

| Slow Speed (600 RPM & Under) | | | (High Speed (601 RPM & Over) | | |
|---|---|---|---|---|---|
| KW Rating | MCF per KW-HR | | KW Rating | MCF per KW-HR | |
| | Below 1/2 Load | 1/2 Load & Above | | Below 1/2 Load | 1/2 Load & Above |
| 0 - 200 | - | - | 0 - 200 | 0.0150 | 0.0145 |
| 201 - 500 | - | - | 201 - 500 | 0.0118 | 0.0108 |
| 501 - 1,000 | 0.0113 | 0.0102 | 501 - 1,000 | 0.0118 | 0.0108 |
| 1,001 - 1,500 | 0.0106 | 0.0095 | 1,001 - 1,500 | 0.0118 | 0.0108 |
| 1,501 - 2,500 | 0.0106 | 0.0095 | 1,501 - 2,500 | - | - |
| 2,501 & over | 0.0110 | 0.0093 | 2,501 & over | - | - |

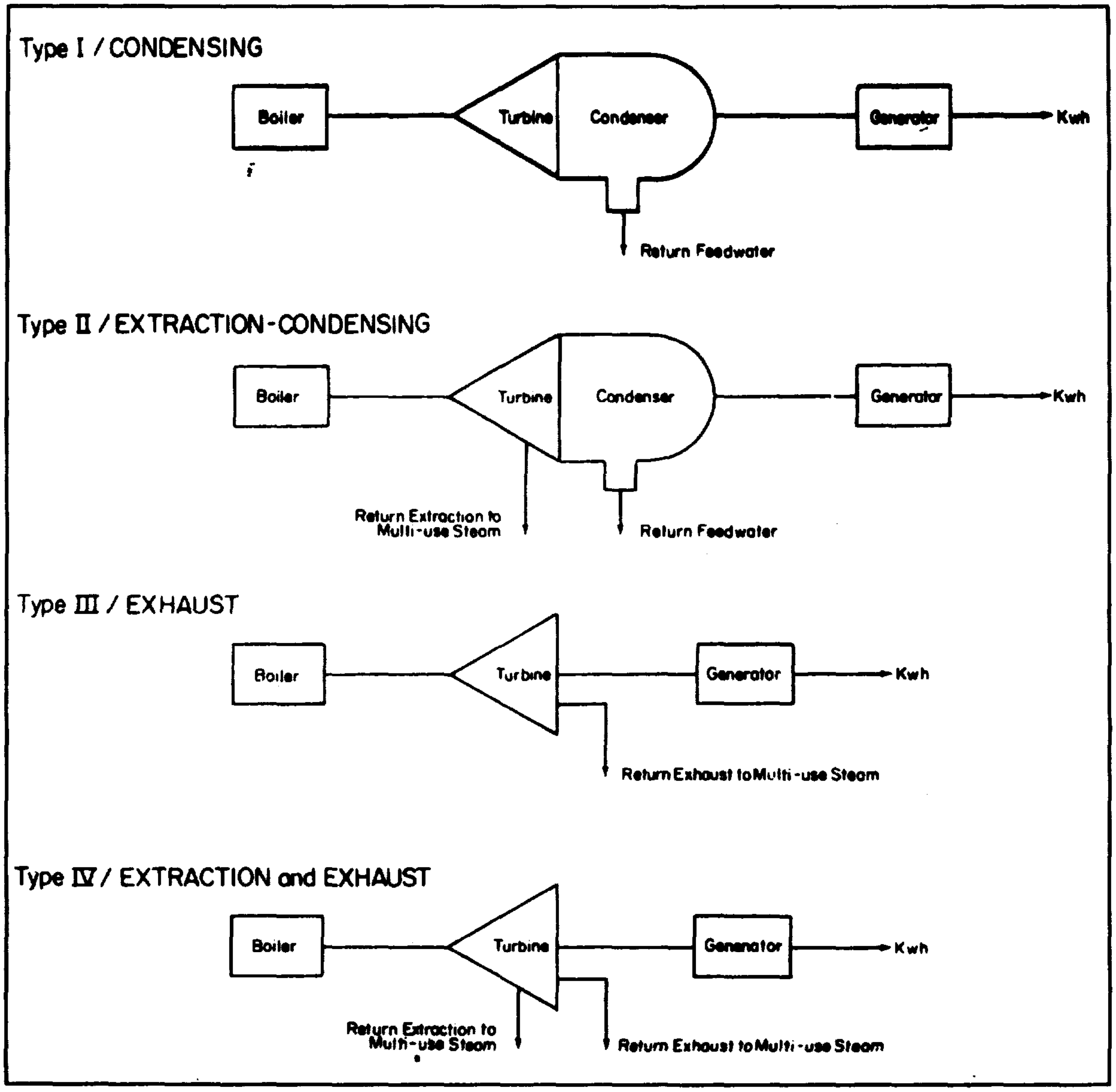



FIGURE 2-2
Basic Types of Steam Generation

TABLE 2-15
Monthly Data for Non-Condensing Units

| | |
|---|---|
| **For Throttle** | |
| (1) Throttle Pressure (psia) = (psig + 15) | 190 |
| (2) Throttle Temperature (°F) | 480 |
| **For Each Extraction** | |
| (3) Extraction Flow (M lbs) | 200 |
| (4) Extraction Pressure (psia) = (psig + 15) | 80 |
| (5) Extraction Temperature (°F) | 375 |
| **For Exhaust** | |
| (6) Exhaust Flow (M lbs) | 350 |
| (7) Exhaust Pressure (psia) = (psig + 15) | 40 |
| (8) Exhaust Temperature (°F) | 300 |

## EXHIBIT 2-18

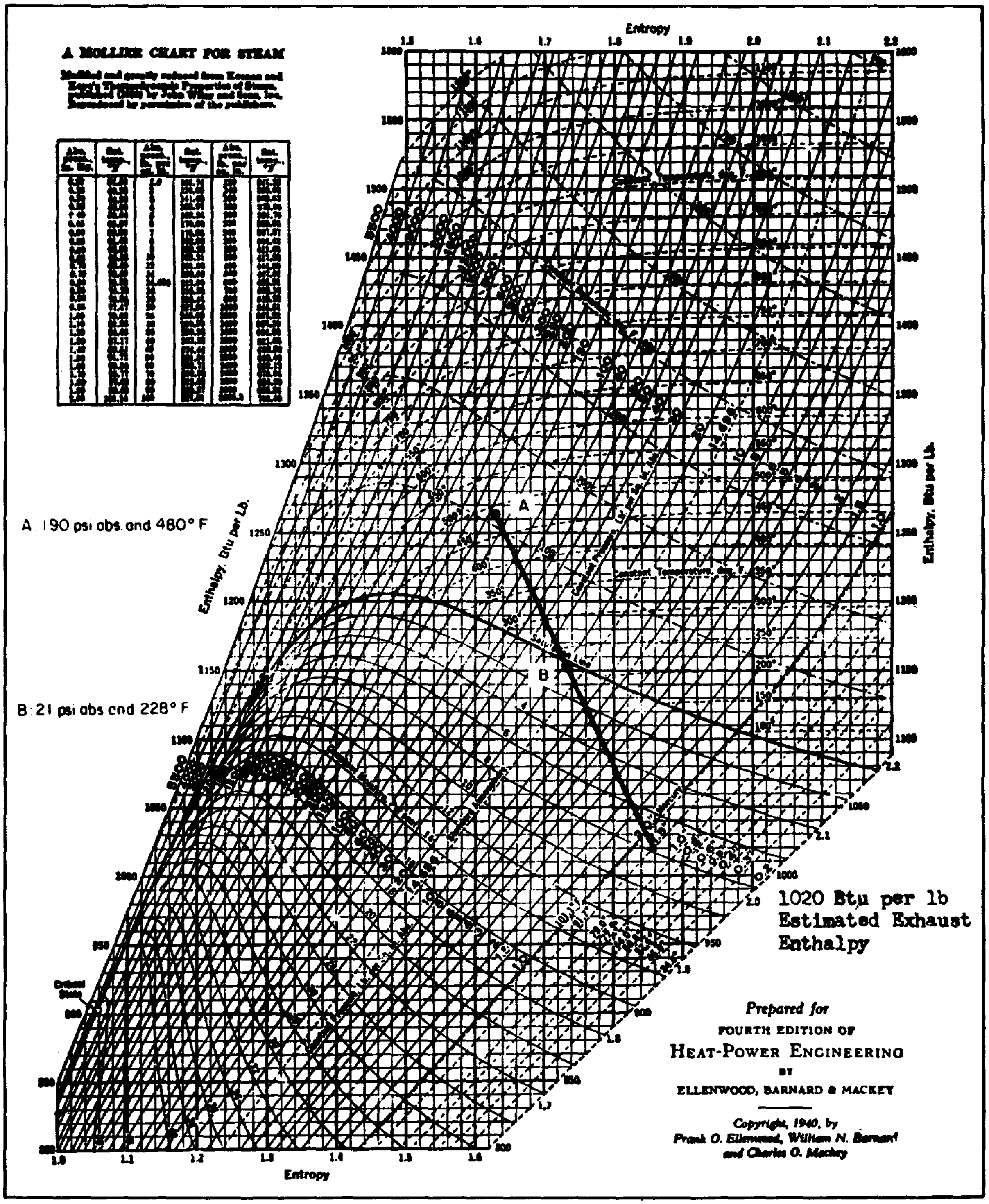



FIGURE 2-3
Mollier Chart

TABLE 2-16
Examples Using Mollier Chart

Example I

(a) Determine the throttle enthalpy for a given throttle temperature of 480°F and throttle pressure of 190 psia (Point A of Fig. 2-3).

(b) Determine the extraction enthalpy for a given extraction temperature of 375°F and extraction pressure of 80 psia.

(c) Determine the exhaust enthalpy for a given exhaust temperature of 300°F and exhaust pressure of 40 psia.

Projection of the given pressure-temperature points on the Mollier chart horizontally to the border yields:

(a) a throttle enthalpy = 1,262 Btu per lb

(b) an extraction enthalpy = 1,220 Btu per lb

(c) an exhaust enthalpy = 1,189 Btu per lb

Example II

Determine the exhaust enthalpy for a turbine having one extraction point given the following conditions:

(a) Throttle steam at a temperature of 480°F and a pressure of 190° psia (point A of Fig. 2-3),

(b) Extraction steam at a temperature of 228°F and a pressure of 21 psia (point B of Fig. 2-3),

(c) Exhaust pressure of 1.5 in. of Hg. abs.

Construct a linear line passing through the pressure-temperature turbine and extraction points on the Mollier chart. Continue this line until it intersects the given exhaust pressure line. Projection of this intersection horizontally to the border will yield the exhaust enthalpy which, for the conditions given above, is equal to 1,020 Btu per lb.

## TABLE 2-17
## Formula for Targeted Pounds of Steam

(1) M Pounds of Steam = $E_E\ (H_T - H_E) / (H_T - F)$ [Non Condensing Type]

(2) M Pounds of Steam = $\left[ E_E\ (H_T - H_E) + \sum_{i=1}^{N} E_i (H_T - H_i) \right] / (H_T - F)$ [Non Condensing Type]

(3) M Pounds of Steam = $\left\{ \dfrac{J(3600) - (H_E - F)}{(H_T - F)} \sum_{i=1}^{N} E_i (H_T - H_i) \right\} / (H_T - H_E)$ [Condensing Unit]

Where

$E_1$ = First Extraction Steam Flow (M Pounds)

$E_N$ = Nth Extraction Steam Flow (M Pounds)

$E_E$ = Exhaust Steam (M Pounds)

$H_T$ = Enthalpy of Throttle Steam (BTU Per Pound)

$H_i$ = Enthalpy of First Extraction Steam (BTU Per Pound)

$H_N$ = Enthalpy of Nth Extraction Steam (BTU Per Pound)

$H_E$ = Enthalpy of Exhaust Steam (BTU Per Pound)

F = Return Make-up Mixture Temperature Minus 32 ($^{\circ}$F) = Equivalent BTUs

J = Energy Output from Line One (1) of Exhibit 2-21 (MKWH)

Example

Calculate using formula (3) the M Pounds of steam for a turbine having four (4) extraction points.

M Pounds of Steam =

$$\frac{\dfrac{J(3600)^{1} - (H_E - F)}{(H_T - F)} \quad E_1(H_T - H_1) + E_2(H_T - H_2) + E_3(H_T - H_3) + E_4(H_T - H_4)}{(H_T - H_E)}$$

[1] Conversion to BTUs

TABLE 2-18
Monthly Data for Condensing Units

| | |
|---|---|
| (1) Energy Output (MKWH) (actual) | 25 |
| **For Throttle** | |
| (2) Throttle Pressure (psia) = (psig + 15) | 190 |
| (3) Throttle Temperature (°F) | 480 |
| **For Each Extraction** | |
| (4) Extraction Flow (M lbs) | 200 |
| (5) Extraction Pressure (psia) = (psig + 15) | 21 |
| (6) Extraction Temperature (°F) | 228 |
| **For Exhaust** | |
| (7) Exhaust Pressure (psia or in. Hg. abs.) where psia = psig + 15 and psia = 2 in. Hg. abs.) | 1.5 in. Hg. |

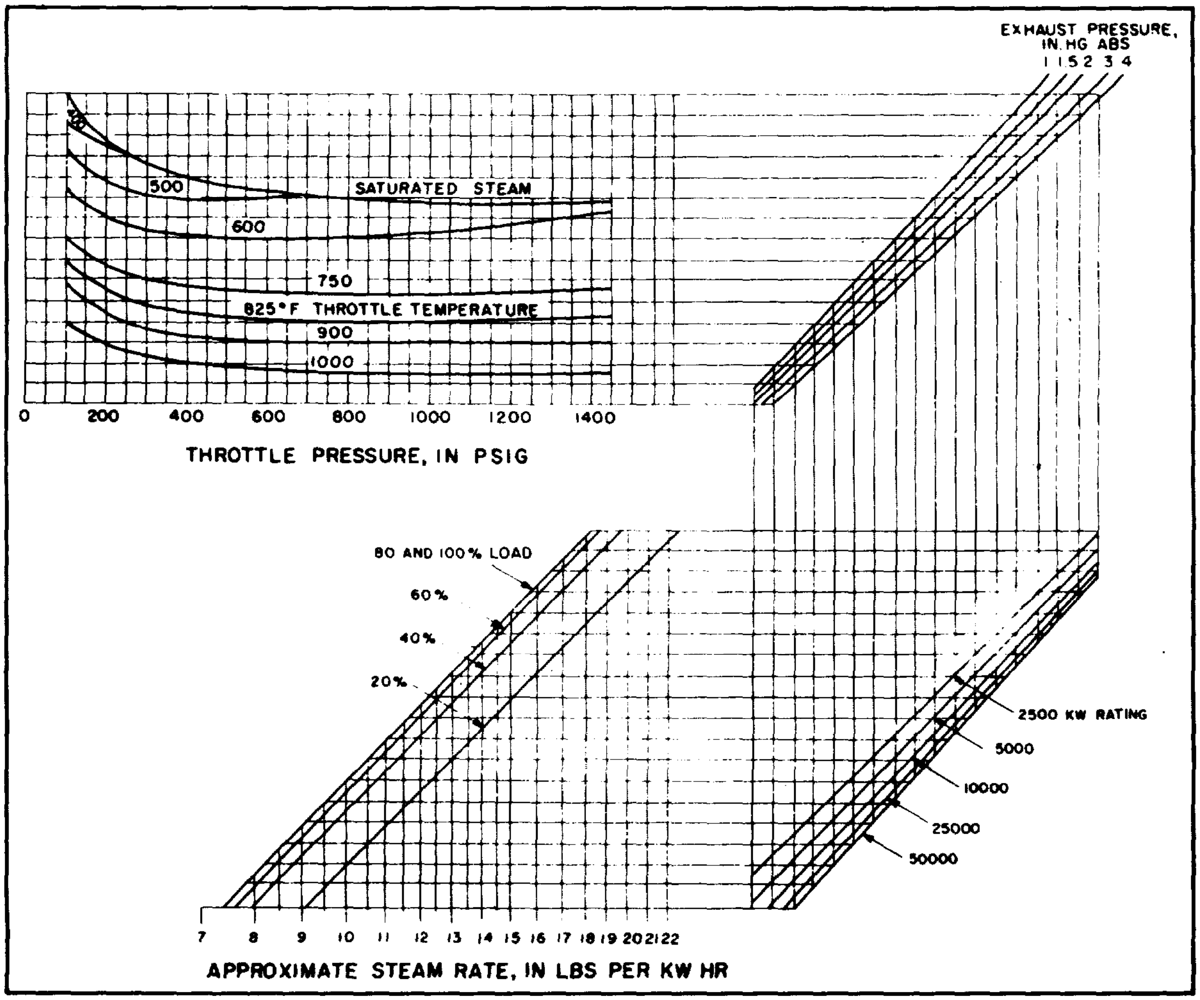



FIGURE 2-4
Approximate Steam Rate Curves

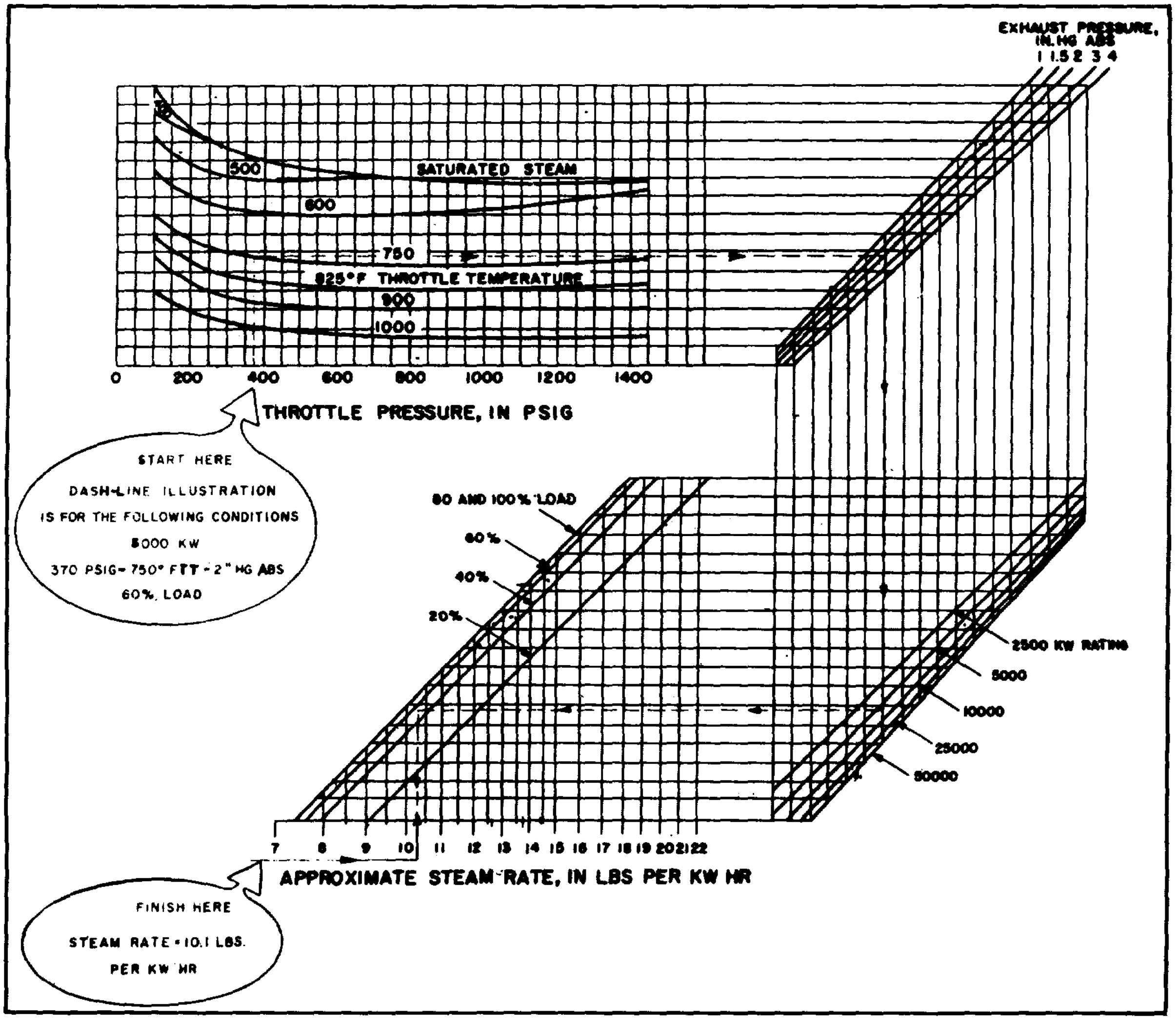



FIGURE 2-5
Example Using Approximate Steam Rate Curves

TABLE 2-19
Monthly Partial Cost of Distribution[1]

| | |
|---|---|
| (1) Operation and Maintenance Labor Cost (actual) | $ 2,717 |
| (2) Operation and Maintenance Contractual and Other Costs (actual) | 1,543 |
| (3) Apportioned General Plant Expense (actual) | 0 |
| (4) General Expense Applied (NIF) (actual) | 0 |
| (5) Partial Cost of Distribution = ((1)+(2)+(3)+(4)) | 4,260 |

[1]Refer to lines thirty-two (32) through thirty-nine (39) on NavCompt Form 2127 for this information.

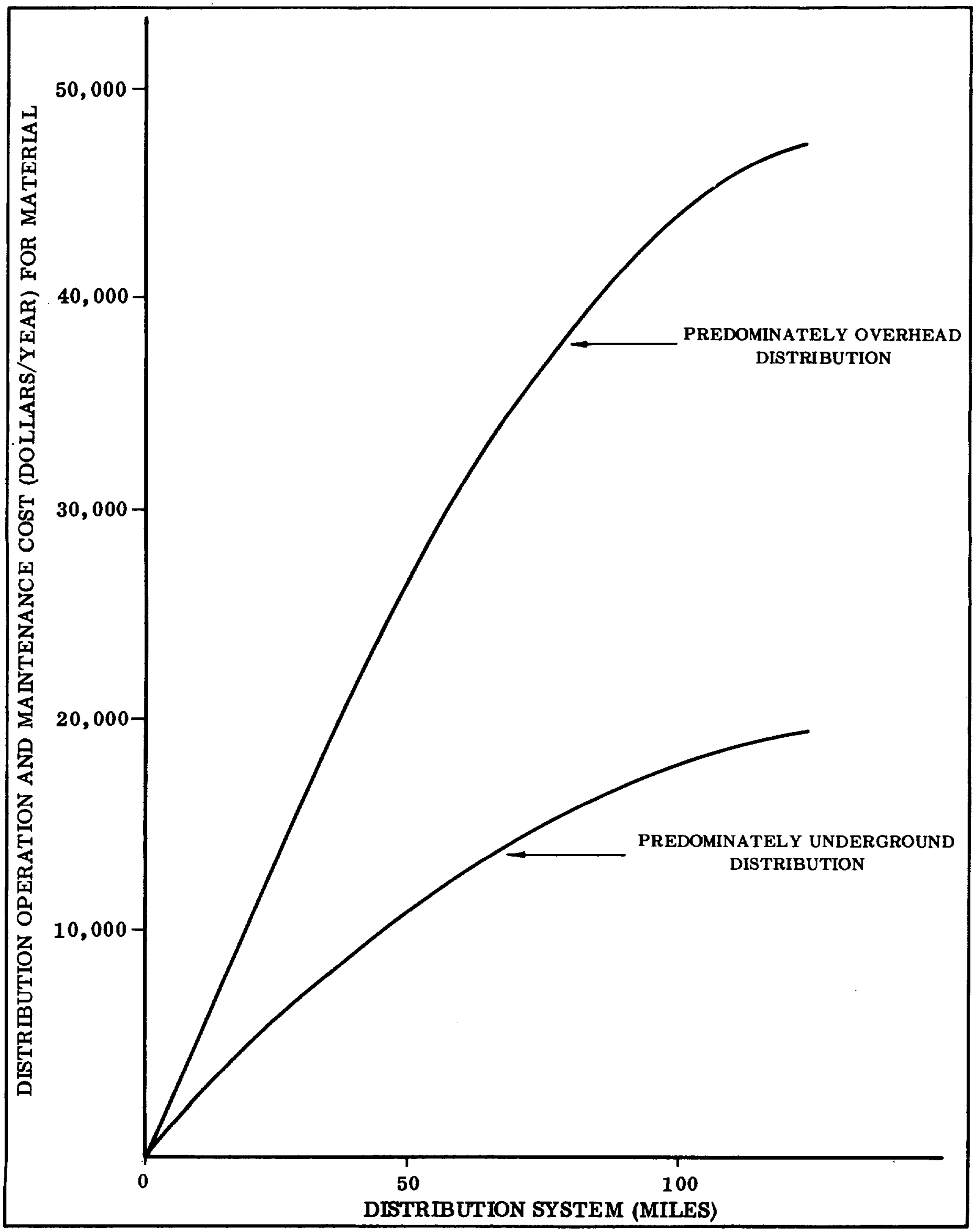



FIGURE 2-6
Annual Operating and Maintenance Costs as a Function of Length of Distribution System

TABLE 2-20 (1 of 4)
Ship Services - Electrical

| Vessels | | Ship's service (hotel)[1] | | | | | |
|---|---|---|---|---|---|---|---|
| Type | Symbol and class | AC-3-phase | | | DC | | |
| | | Volts | Amps | KW | Volts | Amps | KW |
| Aircraft Carriers:[2] | | | | | | | |
| Attack, guided missile | CVA 41 | 450 | 1600 | 1000 | ... | .... | ... |
| Attack, guided missile | CVA 59 | 450 | 3200 | 2000 | ... | .... | ... |
| Attack, guided missile | CVA 63 | 450 | 6400 | 4000 | ... | .... | ... |
| Attack, nuclear | CVA(N) 65 | 450 | 9600 | 6000 | ... | .... | ... |
| ASW support ship | CVS 10 | 450 | 1600 | 1000 | ... | .... | ... |
| Amphibious Warfare Ships:[3,4] | | | | | | | |
| Force flagship | AGC 17 | ... | .... | .... | 120/240 | 2500 | 600 |
| High speed transport (prior to 1947) | APD | 450 | 400 | 250 | ... | .... | ... |
| Transport submarine | APSS 313 | ... | .... | .... | 250[6] | 660 | 165 |
| Transport dock | LPD 1 | 450 | 1600 | 1000 | ... | .... | ... |
| Assault ship | LPH 2 | 450 | 1600 | 1000 | ... | .... | ... |
| Landing ship, dock | LSD 28 | 450 | 800 | 500 | ... | .... | ... |
| Landing ship, tank | LST 1156 | 450 | 400 | 250 | ... | .... | ... |
| Auxiliary Ships:[3] | | | | | | | |
| Destroyer tender | AD 23 | 450 | 1600 | 1000 | ... | .... | ... |
| Degaussing ship | ADG 8 | 450 | 200 | 125 | ... | .... | ... |
| Degaussing ship | ADG 383 | 450 | 400 | 250 | ... | .... | ... |
| Ammunition ship | AE 21 | 450 | 1600 | 1000 | ... | .... | ... |
| Stores ship | AF 55 | 450 | 800 | 500 | 120/240 | 1500 | 360 |
| Combat store ship | AFS 1 | 450 | 1000 | 625 | ... | .... | ... |
| Miscellaneous | AG 153 | 450 | 480 | 300 | ... | .... | ... |
| Miscellaneous | AG 154 | 450 | 480 | 300 | ... | .... | ... |
| Miscellaneous | AG 159 | 450 | 600 | 375 | ... | .... | ... |
| Miscellaneous | AG 164 | 450 | 800 | 500 | ... | .... | ... |
| Miscellaneous | AG 398 | 450 | 200 | 125 | ... | .... | ... |
| Icebreaker | AGB 3 | 450 | 360 | 225 | 120/240 | 210 | 50 |
| Escort research ship | AGDE 1 | 450 | 1200 | 750 | ... | .... | ... |
| Major communications relay ship | AGMR | 450 | 1200 | 750 | ... | .... | ... |
| Radar picket ship (EC 2 conversion) | AGR 1 | 450 | 225 | 140 | ... | .... | ... |
| Surveying ship | AGS 15 | 450 | 400 | 250 | 120/240 | 400 | 96 |
| Surveying ship | AGS 18 | 450 | 160 | 100 | ... | .... | ... |
| Surveying ship | AGS 21 | ... | .... | .... | 120/240 | 600 | 144 |
| Surveying ship | AGS-24 | ... | .... | .... | 120/240 | 200 | 48 |
| Surveying ship | AGS 25 | 450 | 400 | 250 | ... | .... | ... |
| Surveying ship | AGS 30 | 450 | 300 | 187 | ... | .... | ... |
| Auxiliary submarine (except prototype AGSS 569) | AGSS | ... | .... | .... | 250[6] | 660 | 165 |
| Auxiliary submarine | AGSS 569 | ... | .... | .... | 500[7] | 330 | 165 |

## TABLE 2-20 (2 of 4)
## Ship Services - Electrical

| Vessels | | Ship's service (hotel)[1] | | | | | |
|---|---|---|---|---|---|---|---|
| Type | Symbol and class | AC-3-phase | | | DC | | |
| | | Volts | Amps | KW | Volts | Amps | KW |
| Auxiliary Ships:[3] (Continued) | | | | | | | |
| Hospital ship | AH 12 | 450 | 800 | 500 | 120/240 | 1250 | 300 |
| Cargo ship | AK 259 | ... | .... | .... | 240 | 1250 | 300 |
| Attack cargo ship | AKA 112 | 450 | 720 | 450 | ... | .... | ... |
| Light cargo ship | AKL 1 | ... | .... | .... | 120/240 | 400 | 96 |
| Stores issue ship | AKS 1 | ... | .... | .... | 120/240 | 1200 | 288 |
| Stores issue ship | AKS 32 | ... | .... | .... | 120/240 | 600 | 144 |
| Net laying ship | AN | ... | .... | .... | 120 | 500 | 60 |
| Oiler | AO 22 | 230 | 1250 | 400 | ... | .... | ... |
| Fast combat support ship | AOE | 450 | 1200 | 750 | ... | .... | ... |
| Gasoline tanker | AOG 7 | ... | .... | .... | 240 | 800 | 184 |
| Submarine oiler | AOSS | ... | .... | .... | 240 | 660 | 165 |
| Attack transport | APA 248 | 450 | 1600 | 1000 | ... | .... | ... |
| Repair ship | AR 5 | 450 | 1200 | 750 | 120 | 100 | 12 |
| Cable repair or laying ship | ARC 3 | 450 | 440 | 275 | 120/240 | 625 | 150 |
| I.C. engine repair ship/landing craft repair ship (prior to 1947) | ARG/ARL | 450 | 800 | 500 | ... | .... | ... |
| Salvage ship | ARS 6 | ... | .... | .... | 120/240 | 420 | 100 |
| Salvage lifting ship | ARSD 3 | 450 | 160 | 100 | 120/240 | 83 | 20 |
| Submarine tender | AS 19 | 450 | 1600 | 1000 | ... | .... | ... |
| Auxiliary ocean tug | ATA | ... | .... | .... | 120 | 400 | 96 |
| Fleet ocean tug | ATF | ... | .... | .... | 120/240 | 200 | 48 |
| Seaplane tender | AV | 450 | 800 | 500 | ... | .... | ... |
| Advance aviation base ship | AVB 1 | ... | .... | .... | 120/240 | 400 | 100 |
| Advance aviation base ship | AVB 2 | 450 | 400 | 250 | ... | .... | ... |
| Guided missile ship | AVM | 450 | 800 | 500 | ... | .... | ... |
| Small seaplane tender | AVP | 450 | 300 | 187 | ... | .... | ... |
| Aviation supply ships | AVS | ... | .... | .... | 120/240 | 1200 | 288 |
| Unclassified miscellaneous | IX 67 | 450 | 400 | 250 | 120/240 | 400 | 96 |
| Command Ships:[3] | | | | | | | |
| Command ship | CC | 450 | 2400 | 1500 | ... | .... | ... |
| Cruisers:[2] | | | | | | | |
| Heavy | CA 68 | 450 | 2400 | 1500 | ... | .... | ... |
| Heavy | CA 122 | 450 | 1200 | 750 | ... | .... | ... |
| Heavy | CA 139 | 450 | 1600 | 1000 | ... | .... | ... |
| Heavy, guided missile | CAG 2 | 450 | 2400 | 1500 | ... | .... | ... |
| Guided missile | CG 10 | 450 | 2400 | 1500 | ... | .... | ... |
| Guided missile, nuclear | CGN 9 | 450 | 3200 | 2000 | ... | .... | ... |

TABLE 2-21
Energy Target, Ship at Dockside

| | | |
|---|---|---|
| Pier No. 1 Ship DLG(N) ____ | | |
| Special Loads | | |
| Nuclear Master Cooldown | | kw-hr |
| 2 main coolant pumps | 5 hrs at 225 kw each | 2250 |
| 2 main coolant pumps (low speed) | 8 hrs at 35 kw each | 560 |
| 2 FW cooling pumps | 20 hrs at 5 kw each | 200 |
| 2 condensate pumps | 13 hrs at 5 kw each | 130 |
| Controls & auxiliaries | 13 hrs at 20 kw | 260 |
| Cold Plant Operation | | |
| 2 main coolant pumps | 45 hrs at 35 kw each | 3150 |
| Air Compressor | 10 hrs at 20 kw | 200 |
| Battery Charge | | |
| 1680 amp-hr at 440v (line voltage | | 739 |
| Welding, Arc | 2 hrs (est) at 30 kw | 60 |
| TOTAL | | 7549 |
| Hotel Services | | |
| From Table 2-20 (3 of 4) | 2000 kw max. | |
| % crew on board | 33-1/3 | |
| | 667 kw | |
| Hrs shore conn. | 45 | |
| | TOTAL TARGET | 30015 |
| | | 37564 kw-hr |

## CHAPTER 3. TARGETS FOR POTABLE WATER

3.1 GENERAL. Potable water targets are estimates of the quantity of water a Naval shore activity should be using and of what the unit cost of supplying the water should be. They are developed by the EFD and maintained by the activity under the assumption that all practical conservation measures are in effect. Targets may be established for quarterly, yearly or longer periods depending on the size and mission of the activity. If an activity is small or able to provide water at a very low cost, longer target periods and more simple target calculations are justifiable since savings due to target analysis are likely to be small. The same is true of installations which supply large quantities of water at high unit cost to industrial and other uses which may not be predictable but are essential to the mission of the activity. An example of this would be an activity which uses upwards of 85 percent of its water supply for the repair and provisioning of ships. A two year target based on no more than past and projected consumption would likely suffice. Yet a large installation which uses 85 percent of a water supply maintained at a high unit cost for the support of personnel, or where water is in short supply, should calculate a detailed target for at least each quarter of the fiscal year. Most water uses are listed in NAVFAC DM-5, Civil Engineering. Special uses may be added where required by conditions at the activity.

3.2 CLASSIFICATION OF USES. In order to establish and compare targets within and among Naval activities, water uses are grouped under several classifications: domestic, industrial, and maintenance. Water which is transferred to some reimbursable use and water system losses are also considered as separate "uses."

3.2.1 Domestic Uses.

(1) Domestic Water Allowance: The average daily water usage for each class of population, expressed in gallons per person per day. Allowances listed in Table 3-4 should be used unless measurements justify revised allowances.

(2) Full-time Population: The average number of military personnel, civilian personnel, and dependents living during the period at the Naval activity.

(3) Part-time Population: The average number of assigned military and civilian personnel present for one shift per day during the period at the Naval activity.

(4) Hospital Bed Population: The average number of bed patients residing during the period in a Naval hospital.

(5) Transient Population: The average number of military and civilian personnel who register as visitors during each day of the period at the Naval activity.

3.2.2 Industrial Uses (Table 3-6).

(1) Air-Conditioning Allowance: The average water usage of air-conditioning units rated at 5 tons cooling capacity or greater and is expressed in gallons per day.

(2) Boiler Feedwater Allowance: The average daily water usage by each industrial boiler for makeup and filter backwashing. Allowances should be determined for each activity by the EFD.

(3) Machinery Cooling Allowances: The average hourly water usage for each type of machinery expressed in gallons per hour of operation. Typical items are air compressors and diesel engines. Allowance for recirculation type air compressors is three gallons per horse-power hour. Other allowances should be determined for each activity by the EFD.

(4) Swimming Pool Allowance: The average daily water usage for days during which pool is in operation. Included are pools primarily intended for training. Allowances for indoor pools are 0.03 gallons per gallon capacity for recirculating type and 0.10 gallons per gallon for fill and draw type.

3.2.3 Maintenance Uses.

(1) Lawn Sprinkling and Irrigation Allowance: The average monthly water usage based on temperature, sunlight, rainfall, and soil. It is expressed in gallons per acre per month. If appreciable quantities of water are used for irrigation, allowances should be calculated in accordance with Table 3-7 as explained in NAVFAC DM-5.

(2) Equipment Washing Allowance: The average monthly water usage based on period, equipment size and frequency of washing. It is expressed in gallons per equipment item per month. Monthly allowances for government and private cars, trucks, and buses are 50, 100 and 250, respectively. Other allowances such as for automatic car washing facility should be determined by experience for each activity. If private car washing facilities are provided, determine the number of private cars owned by full population and adjust the allowance as necessary.

(3) Street Flushing Allowance: The average monthly water usage for cleaning paved streets and parking lots. The suggested allowance is one gallon per square yard per month. If actual flushing is reduced because of rain or snow, the allowance for the month should be reduced.

(4) Fire Hydrant Flushing Allowance: The average water discharge, both for testing hydrant pressure and for clearing distribution lines of stagnant water, expressed as 750 gallons per hydrant minute. The number of hydrants flushed per period and the time to obtain clear flow should be determined by experience for each activity.

(5) Fire Fighting Allowance: The total quantity of water reported for the period.

3.2.4 Reimbursable Uses. When large quantities of potable water are delivered to other activities, the water should ordinarily be metered and its cost reimbursable. These activities may include Officers' Mess, Navy Exchange, ships, housing, and commissary. If these conditions are not satisfied and the use remains under control of the activity, it may be inserted as a special use under Industrial Uses.

3.2.5 System Losses.

(1) Production Allowance: The average daily usage for back-washing filters or other losses chargeable to the production system. Allowances

for filters are 2 percent of the water filtered. Other allowances should be determined by each activity.

(2) Distribution Allowance: The average daily leakage at pipe joints and valves expressed in gallons per inch-mile of diameter and length per day. Allowances are 50 gallons/inch-mile/day for rubber gasketed joints and 80 gallons/inch-mile/day for lead-caulked bell and spigot joints.

(3) Freeze-up Protection: The average daily leakage at pipe valves when they are unseated or bypassed to prevent freeze-up. Allowances should be determined for each activity by the EFD and should only apply for the number of days of subfreezing temperatures.

3.3 QUANTITY TARGETS.

3.3.1 Procedure. Initial metered or estimated quantities are usually based on a calendar month. Special forms for collecting this data should be prepared by each activity. If feasible, arrangements should be made with the supplier of any purchased water to take meter readings on or near the last day of the month. If such arrangements are not feasible, it may be preferable for activity personnel to take additional end-of-the-month readings. If water meters are not provided for some uses, consider a procedure for measuring such water quantities during periodic inspection.

Total quantities for each use classification should be recorded at intervals compatible with the length of the target period, the metering procedures of any procuring agency, and the importance of the uses which make up the target. For minor or unmetered uses, total quantities for the target interval may be calculated from daily or hourly allowances (assuming 91 days or 2184 hours for a quarter). Interutility transfers of potable water are not listed in a separate use classification but should be listed under Industrial Uses. Demineralized water transferred to ships should be listed as a separate utility but the original potable water should be treated like other interutility transfers of potable water.

3.3.2 Sample Calculations. The breakdown of time durations and allowances is made on a form like that in Table 3-1. Most entries are either obvious or are explained in Classification of Uses. Since extreme accuracy is not necessary many total use quantities may be rounded off to the nearest thousand gallons or to the fourth significant figure.

Special Uses under Industrial Uses include those uncommon uses related to the activity's mission which require further explanation. Examples include washing aircraft at a Naval air station, filling a diving test tank, or large factory operations. Special Uses under Maintenance Uses include any significant consumptive uses, which are not already described or which should be separately identified. Special Uses under Reimbursable Uses include large consumptive uses, which should be separated from the several general categories already listed. Examples include recreational swimming pools, golf courses, and family residential developments. As has been already noted, targets for Reimbursable Uses should be based on metered or estimated usage and not on allowances not under the control of the landlord activity. The various tenants of the Naval activity may calculate and control their own allowances by referring to above allowances for swimming pools, lawn sprinkling, and personnel.

3.3.3 Analysis of Results. Comparison of quantity targets with actual quantities of potable water produced or purchased in the same period should indicate the efficiency of utilization. When the variance warrants, a systematic investigation should be conducted to determine the causes in accordance with BUDOCKSINST 11,300.11. Examples of causes of excessive use or loss are as follows:

(1) Losses may triple when operating pressure exceeds 120 p.s.i.. A definite relation between service pressure and distribution main losses exists (see Figure 3-1). At normal pressures (in the order of 50 to 80 p.s.i.) losses range from 70 to 250 gallons per inch-mile per day, depending on pipe size, type of joints, etc.

(2) If water furnished to tenants is not metered, revaluation of the consumption may be necessary, especially if the function of the tenant has changed or the number of persons has substantially varied.

(3) Spot measure non-tower type air-conditioning and refrigeration use. If much higher than the recommended allowance of 180 gallons per ton-hour, the condition of the equipment should be checked.

(4) If excessive distribution main leakage is suspected, a leak survey should be planned and conducted with the aid of the EFD. Although costly, the net savings may more than offset the initial cost.

(5) Unusual weather conditions or equipment failure should be evaluated. Considerable water may be used or lost before repairs are complete.

Reimbursable users should review target data for their uses. If incentives to conserve potable water are not inherent in the established method of charging users, they should be initiated both by the activity responsible for supplying the water and by the user.

3.4 UNIT COST TARGETS.

3.4.1 Procedure. Unit cost targets shall be developed for the cost of utility produced and the cost of utility delivered, based upon the actual quantities produced and delivered. Potable water unit cost targets are defined as the average cost per 1000 gallons when operating efficiency, scheduling and maintenance are handled so as to produce the required quantity at the lowest possible cost. Annual operation and maintenance costs are based on quantities from the UCAR of the prior fiscal year and on costs taken from typical curves of historical data. Remaining production and distribution costs are taken from the UCAR for the current quarter.

Activities producing all or some of their water requirement should follow a common procedure to calculate unit cost targets. Annual operation and maintenance costs are split into quarterly production and distribution costs. After all quarterly production, distribution and indirect costs are tabulated, the cost targets for produced and delivered water are calculated. Activities purchasing all or some of their water requirement should follow a common procedure to calculate unit cost targets. If the activity must increase water pressure, the additional pumping operation and maintenance costs are calculated separately based on electrical energy required. After all quarterly distribution and indirect costs are tabulated, the cost target for delivered water is calculated.

3.4.2 Sample Calculations. Quantities and costs for produced and purchased water should be entered in Tables 3-2 and 3-3, respectively. Care must be exercised to base quantities on the correct units and time intervals. If water is both produced and purchased the approximate costs should be divided between summary sheets. Item number 1-c, length of mains, on each summary should be the same for all four quarters in the fiscal year. Unless a detailed tabulation of quarterly maintenance costs has been prepared, quarterly maintenance costs should be one fourth of annual maintenance costs.

3.4.3 Analysis of Results. Comparison of unit cost targets for produced and purchased water with actual costs should indicate the efficiency of utilization. Efforts to explain and reduce large variances should emphasize large unexpected expenditures and influence of quantity targets on unit cost targets. Activities which can both produce and purchase potable water should periodically compare their unit costs. The unit cost of produced water may be much larger if only small quantities are produced in a quarter. Thus continuous use of both produced and purchased water would be justifiable only on a basis other than cost, such as limited capacity or reliability of backup supply. Additional calculations may be necessary to base this produce-vs-purchase comparison on the same delivered quantities and to separate unique and common items of cost.

TABLE 3-1 (1 of 4)
Sample Potable Water Quantity Target Summary

(Use additional sheets where necessary and code to applicable question)

| Activity | Targets By | Data |
|---|---|---|

1. Domestic Uses

| | Month | | Population[1] | | Allowance from Table 3-4 | | Days | Thousand Gallons |
|---|---|---|---|---|---|---|---|---|
| a. Full Time | | | | | | | | |
| | ______ | : | ______ | x | ______ | x | ____ | ______ |
| | ______ | : | ______ | x | ______ | x | ____ | ______ |
| | ______ | : | ______ | x | ______ | x | ____ | ______ |
| b. Part Time | | | | | | | | |
| | ______ | : | ______ | x | ______ | x | ____ | ______ |
| | ______ | : | ______ | x | ______ | x | ____ | ______ |
| | ______ | : | ______ | x | ______ | x | ____ | ______ |
| c. Hospital Bed Patients | | | | | | | | |
| | ______ | : | ______ | x | ______ | x | ____ | ______ |
| | ______ | : | ______ | x | ______ | x | ____ | ______ |
| | ______ | : | ______ | x | ______ | x | ____ | ______ |
| d. Transients | | | | | | | | |
| | ______ | : | ______ | x | ______ | x | ____ | ______ |
| | ______ | : | ______ | x | ______ | x | ____ | ______ |
| | ______ | : | ______ | x | ______ | x | ____ | ______ |

Total Domestic Uses ______

[1]Exclude population associated with true cash reimbursables.

TABLE 3-1 (2 of 4)
Sample Potable Water Quantity Target Summary

| 2. Industrial Uses | Thousand Gallons |
| --- | --- |
| a. Air-Conditioning, minimum 5 tons. | |
| _____ tons x _____ hours x _____ gals/ton-hour | _____ |
| _____ tons x _____ hours x _____ gals/ton-hour | _____ |
| _____ tons x _____ hours x _____ gals/ton-hour | _____ |
| b. Ship Consumption (Only if not reimbursable) | |
| _____ days of delivery x _____ gals/day | _____ |
| _____ days of delivery x _____ gals/day | _____ |
| c. Boiler Feedwater (Industrial process) | |
| _____ days of operation x _____ gals/day | _____ |
| _____ days of operation x _____ gals/day | _____ |
| d. Machinery Cooling (Identify types) | |
| _____ hours of operation x _____ gals/hour | _____ |
| _____ hours of operation x _____ gals/hour | _____ |
| _____ hours of operation x _____ gals/hour | _____ |
| e. Swimming Pools (primarily for training, or not reimbursable) | |
| _____ days of operation x _____ gal capacity x gal/gal | _____ |
| f. Special (Explain) | |
| _____ days of operation x _____ gals/day | _____ |
| _____ hours of operation x _____ hours/day | _____ |
| Total Industrial Uses | _____ |

TABLE 3-1 (3 of 4)
Sample Potable Water Quantity Target Summary

| 3. Maintenance Uses | Thousand Gallons |
|---|---|
| a. Lawn Sprinkling & Irrigation (Table 3-7) | |
| ____ Acres x _____ AF/A x 326,000 gal/AF | ______ |
| b. Equipment Washing | |
| Gov't cars: ______ washed x ______ gal/month x 3 months | ______ |
| Private cars: ______ washed x ______ gals/month x 3 months | ______ |
| Trucks: ______ washed x ______ gals/month x 3 months | ______ |
| Buses: ______ washed x ______ gals/month x 3 months | ______ |
| c. Street Flushing | |
| ______ sq yds x ______ gals /sq yd (by hose) | ______ |
| ______ full tanks x ______ gals/tank (by street sweeper) | ______ |
| d. Fire Hydrant Flushing | |
| ______ hydrants x ______ min x ______ gals/hyd - min | ______ |
| e. Fire Fighting | |
| Sum of quantities reported in NAVFAC Form 1163 | |
| f. Special (Explain) | |
| ______ days of operation x ______ gals/day | ______ |
| ______ days of operation x ______ gals/day | ______ |
| Total Maintenance Uses | ______ |
| New Water Consumed Quantity Target (i.e. Total of all above uses.) | ______ |

TABLE 3-1 (4 of 4)
Sample Potable Water Quantity Target Summary

| | | Metered or Estimated | | Thousand Gallons |
|---|---|---|---|---|
| 4. | Reimbursable Uses | | | |
| | a. Officer's Mess | ____ | ____ | ____ |
| | b. Navy Exchange | ____ | ____ | ____ |
| | c. Ships | ____ | ____ | ____ |
| | d. Housing | ____ | ____ | ____ |
| | e. Commissary | ____ | ____ | ____ |
| | f. Special (Explain) | ____ | ____ | ____ |
| | Total Reimbursable Uses | | | ____ |
| | Net Water Delivered Quantity Target (i.e. Total of all above uses) | | | ____ |
| 5. | Losses | | | |
| | a. Production (i.e. Quantities Used in Production) | | | |
| | ____gallons x .02 filter rate in gal/gal | | | ____ |
| | Ref: NAVCOMPT Form 2126/2127 for production | | | |
| | b. Distribution | | | |
| | ____days ____inch-miles____gals /inch-mile/day | | | ____ |
| | ____days____inch-miles____gals /inch-mile/day | | | ____ |
| | c. Freeze-up Prevention ____days x ____valves x ____gals /valve/day | | | ____ |
| | Total Losses | | | ____ |
| | e. Net Water Produced and Purchased Quantity Target. (i.e. Total of all above Uses and Losses) Enter in UCAR, Line 7 | | | ____ |
| | f. Actual Water Produced and Purchased Quantity (UCAR, Line 6) | | | ____ |
| | g. Ratio of Actual to Target Water Quantity | | | ____ |
| | h. Variance of Actual from Target Quantity [i.e. 100 (Item 5g-1.0] | | | ____ |

TABLE 3-2 (1 of 2)
Sample Produced Potable Water Unit Cost Summary

(Use additional sheets where necessary and code to applicable question.)

| Activity | Targets by | Date |
|---|---|---|
| 1. Quantities from Current UCAR, Quarter of FY . | | |
| a. Net plant production (UCAR, Line 3), thousand gal | | ______ |
| b. Net quantities delivered (UCAR, Line 11), thousand gal | | ______ |
| c. Inventory of distribution system (linear ft) | | ______ |
| 2. Net Plant Production from Prior UCAR, FY 19 . | | |
| a. 1st quarterly quantity (UCAR, Line 3), thousand gal | | ______ |
| b. Annual quantity (UCAR, Line 3), thousand gal | | ______ |
| c. Ratio of quarterly to annual quantity (Item 2a ÷ Item 2b) | | ______ |
| 3. Estimated Annual Operation & Maintenance Costs | | |
| a. Operation cost from Figure 3-2 at Item 2b | | $______ |
| b. Percent of operation cost for production (Table 3-8A) | | ______% |
| c. Maintenance cost from Figure 3-3 at Item 1c | | $______ |
| d. Percent of maintenance cost for production (Table 3-8B) | | ______% |
| 4. Delivered Costs for Current Quarter | | |
| a. Operation cost (Item 2c x Item 3a) | | $______ |
| b. Maintenance Cost (1/4 x Item 3c) | | $______ |
| c. Electricity transfer (UCAR, Line 27) | | $______ |
| d. Potable water transfer (UCAR, Line 28) | | $______ |
| e. Apportioned gen. plant exp., prod. (UCAR, Line 24) | | $______ |
| f. Gen. expense applied (NIF), prod. (UCAR, Line 25) | | $______ |
| g. Apportioned gen. plant exp. (NIF), dist. (UCAR, Line 42) | | $______ |
| h. Gen. expense applied, dist. (UCAR, Line 43) | | $______ |
| i. Total cost (Sum of above 8 items) | | $______ |
| j. Unit cost target delivered (Item 4i ÷ Item 1b), $/thousand gal. Enter Item 4j in UCAR, Line 47. | | $______ |
| k. Actual unit cost (UCAR Line 46), $/thousand | | ______ |
| l. Ratio of actual to target cost | | ______% |
| m. Variance of actual from target cost (100 x (Item 4l - 1.0)) | | ______ |
| 5. Production Costs for Current Quarter, Quarter of FY 19 | | |
| a. Apportioned operation cost (Item 3b x Item 4a) | | $______ |
| b. Apportioned maintenance cost (Item 3d x Item 4b) | | $______ |
| c. Electricity transfer (UCAR, Line 27) | | $______ |

TABLE 3-2 (2 of 2)
Sample Produced Potable Water Unit Cost Summary

| | |
|---|---|
| 5. Production Costs for Current Quarter, Quarter of FY 19 (Continued) | |
| d. Potable water transfer (UCAR, Line 28) | $ ______ |
| e. Appor. gen. plant exp., prod. (UCAR, Line 24) | $ ______ |
| f. Gen. expense applied, prod. (UCAR, Line 25) | $ ______ |
| g. Total cost (Sum of above 6 items) | $ ______ |
| h. Unit cost target produced (Item 5g + Item 1a), $/thousand gal Enter Item 5h in UCAR, Line 49. | ______ |
| i. Actual unit cost (UCAR, Line 48), $/thousand gal. | $ ______ |
| j. Ratio of actual to target cost | ______ |
| k. Variance of actual from target cost (100 x (Item 5j - 1.0)) | ______% |

TABLE 3-3 (1 of 2)
Sample Purchased Potable Water Unit Cost Summary

(Use additional sheets where necessary and code to applicable question.)

| Activity | Targets by | Date |
|---|---|---|

1. Quantities from Current UCAR, ___ Quarter of FY 19 ___.

   a. Purchased quantity (UCAR, Lines 4 and 5), thousand gal ______
   b. Net quantities delivered (UCAR, Line 11), thousand gal ______
   c. Inventory of distribution system (linear ft) ______

2. Purchased Quantities from Prior UCAR, FY 19 ___.

   a. _____quarterly quantity (UCAR, Line 4), thousand gal ______
   b. Annual quantity (UCAR, Lines 4 and 5), thousand gal ______
   c. Ratio of quarterly to annual quantity ______

3. Pumping Costs from Prior UCAR, FY 19 ___.

   a. Electricity transfer (UCAR, Line 27) $______
   b. Total production & purchase (UCAR, Line 35) $______
   c. Ratio of electricity to total cost (Item 3a ÷ Item 3b) ______
   d. Production cost percentage from Figure 3-4 at Item 3c ______%
   e. Production operation cost from Figure 3-5 at Item 2b $______
   f. Production maintenance cost from Figure 3-6 at Item 1c $______

4. Estimated Annual Operation and Maintenance Costs.

   a. Pumping operation cost (Item 3d x Item 3e) $______
   b. Distribution operation cost from Figure 3-7 at Item 2b. $______
   c. Total operation cost (Item 4a + Item 4b) $______
   d. Pumping maintenance cost (Item 3d x Item 3f) $______
   e. Distribution maintenance cost from Figure 3-8 at Item 1C $______
   f. Total maintenance cost (Item 4d + Item 4e) $______

5. Delivered Costs for Current Quarter, ___ Quarter of FY 19 ___.

   a. Operation cost (Item 2c x Item 4c) $______
   b. Maintenance cost (1/4 x Item 4f) $______
   c. Purchased water (UCAR, Lines 33 and 34) $______
   d. Electricity transfer (UCAR, Line 27) $______
   e. Potable water transfer (UCAR, Line 28) $______
   f. Appor. gen. plant exp., prod. (UCAR, Line 24) $______
   g. Gen. expense applied, prod. (UCAR, Line 25) $______
   h. Appor. Gen. Plant exp., dist. (UCAR, Line 42) $______
   i. Gen. expense applied, dist. (UCAR, Line 43) $______
   j. Total cost (Sum of above 9 items) $______

TABLE 3-3 (2 of 2)
Sample Purchased Potable Water Unit Cost Summary

| | |
|---|---|
| k. Unit cost target delivered (Item 5j + Item 1b), $/thousand gal. Enter Item 4k in UCAR, Line 47. | ______ |
| l. Actual unit cost delivered (UCAR, Line 46) $/thousand gal | ______ |
| m. Ratio of actual to target cost | ______ |
| n. Variance of actual from target cost (100 x (Item 5m-1.0)) | ______% |

TABLE 3-4
Monthly Water Allowances for Fulltime Population

| Month | Gallons/person/day | Month | Gallons/person/day |
|---|---|---|---|
| January | 50 | July | 90 |
| February | 50 | August | 90 |
| March | 55 | September | 70 |
| April | 60 | October | 60 |
| May | 70 | November | 55 |
| June | 80 | December | 50 |

NOTES:

1. The above allowances are based on an average annual usage of 65 gallons per person per day for the north temperate zone. For the south temperate zone the allowances for January through June should be interchanged with the allowances for July through December, respectively. For frigid zones the allowances should be reduced and for the torrid zone the allowances should be increased in accordance with recommendations of the Engineering Field Division.

2. Allowance for part time population is equal to allowance for full time population multiplied by 1/4.

3. Allowance for hospital bed patients is 100 gallons per day.

4. Allowance for Transients is 16 gallons per day.

| Vessels | | Water (fresh) | |
|---|---|---|---|
| | | Quantity | |
| Type | Class | g.p.d. | p.s.i. |
| Amphibious: | | | |
| Force flagship | AGC 17 | 25,000 | 90 |
| Transport, dock | LPD 1 | 13,900 | 60 |
| Assault ship | LPH 2 | 16,000 | 75 |
| Landing ship, dock | LSD 28 | 8,000 | 60 |
| Landing ship, tank | LST 156 | 6,000 | 60 |
| Auxiliaries: | | | |
| Destroyer tender | AD 23 | 18,600 | 90 |
| Ammunition ship | AE 21 | 18,000 | 70 |
| Stores ship | AF 55 | 7,700 | 60 |
| Ice breaker | AGB 3 | 900 | 40 |
| Cargo ship | AK 259 | 6,000 | 60 |
| Attack, cargo ship | AKA 112 | 20,000 | 70 |
| Oiler | AO 22 | 8,900 | 60 |
| Gasoline tanker | AOG 7 | 3,600 | 60 |
| Attack transport | APA 248 | 30,000 | 70 |
| Repair ship | AR 5 | 32,000 | 50 |
| Cable repair or laying ship | ARC 3 | 10,000 | 60 |
| Salvage ship | APS 6 | 3,500 | 30 |
| Salvage lifting ship | APSD 3 | 2,000 | 60 |
| Submarine tender | AS 19 | 18,000 | 60 |
| Sub rescue vessel | ASR | 2,800 | 40 |
| Mine Warfare Ships: | | | |
| Minesweeper, fleet (steel hull) | EMSF 373 | 1,300 | 40 |
| Support ship, mine counter measures | MCS 6 | 1,300 | 40 |
| Minehunter, coastal | MHC 43 | 1,300 | 40 |
| Minesweeper, coastal | MSC 209 | 800 | 40 |
| Minesweeper, coastal | MSC 289 | 1,200 | 40 |
| Cruisers: | | | |
| Heavy, guided missile | CAG 2 | 40,000 | 40 |
| Guided missile, nuclear | CGN 9 | 40,000 | 60 |
| Tactical command ship | CLC 1 | 40,000 | 40 |
| Carriers: | | | |
| Attack, nuclear | CVAN 65 | 42,000 | 100 |
| Attack, guided missile | CVA 63 | 42,000 | 100 |
| Attack | CVA 41 | 40,000 | 75 |
| Support ship (ASW) | CVS 10 | 37,000 | 65 |
| Destroyers: | | | |
| Destroyer leader, guided missile, frigate, nuclear | DLG(N) 25 | 13,000 | 70 |
| Destroyer leader | DL & DLG | 12,000 | 60 |
| Destroyer | DD 931 & DDG | 10,000 | 60 |
| Escort destroyer | DE 1006, etc. | 5,000 | 50 |

## TABLE 3-5 (2 of 2)
## Water - Ship to Shore

| Vessels | | Water (fresh) | |
|---|---|---|---|
| | | Quantity | |
| Type | Class | g.p.d. | p.s.i. |
| **Submarines:** | | | |
| Fleet type – prior to SS 563 | ........ | 2,400 | 15 |
| SSR & SSK conversions & SST 1, 2.3 | ........ | 540 | 15 |
| SSK 1, 2, 3 | ........ | 2,400 | 15 |
| SS 563 class, SS 574 | ........ | 2,400 | 15 |
| SS 569 | ........ | 2,400 | 15 |
| SS 572, 573 | ........ | 2,800 | 15 |
| SS 576, 577, 580-582 | ........ | 2,500 | 15 |
| SSN | ........ | 3,000 | 20 |
| SSBN | ........ | 3,000 | 40 |
| SSRN | ........ | 5,160 | 20 |
| **Patrol ships:** | | | |
| Submarine chaser | EPC-618 | 1,000 | 50 |
| Escort ship, rescue | EPCER-849 | 2,500 | 50 |
| **Vessels** | | | |
| ADG, AGH, AGSS, APSS, ATA, ATF, ATS, IX-21, IX-87, IV-3 | ........ | 10,000 | 60 |
| AN, DEG, DER, MSO, MSS, PC, PCE, PCH, PCS, PGM | ........ | 10,000 | 60 |
| APD, DDE, DDR | ........ | 20,000 | 60 |
| AGDE, CA, CC, CG, CLG | ........ | 40,000 | 60 |
| AVP | ........ | 10,000 | 60 |
| SSG (N) | ........ | 10,000 | 60 |
| AFS, AG (SS pre '47), AGMR, AGR, (AKV-CONV), AGS, AGSC, AH-12, AKL (pre '47), AKS (pre '47), AOE, AOR, ARG/AHL (pre '47), AV, AVB, AVM, AVS | ........ | 40,000 | 60 |

TABLE 3-6
Industrial Water Usage

| Equipment | Recirculating | Non-Conserving |
|---|---|---|
| Air Conditioners | 3.0 gal/ton-hr | 180 gal/ton-hr |
| Diesel Generators | 0.6 gal/brake hp-hr | 20 gal/brake hp-hr |
| Steam Generators | 48.0 gal/kw-hr | -- |
| Air Compressors | 3.0 gal/hp-hr | -- |
| Swimming Pools | 3.0 gal/100 gal volume | 10 gal/100 gal volume |

TABLE 3-7
Lawn Sprinkling Allowances

Reference: Civil Engineering, NAVFAC DM-5, Chapter 13.

Latitude: ____________________ , K = ____________ , E: ______________

| Column Number | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Month | Mean Temp t (deg F) | Daylight Percent P | $f = \frac{tP}{100}$ | U = fK (in) | Mean Rainfall r (in) | Allowance $\frac{U - r}{E}$ (in) | Allowance (AF/A) |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

Basic Formula

$$U = fK = \frac{KtP}{100}$$ (Blaney - Criddle equation)

Where:

U = Consumptive water use in inches.

K = Evapotranspiration coefficient, .70 for Grassland, .35 for Barmuda grass.

E = Water application efficiency = .70 for average soil conditions = .60 for sandy soil

NOTES:

1. Data for columns 1 and 5 are provided in monthly weather report, Local Climatological Data, available from U. S. Weather Bureau.
2. Data for Column 2 are provided in Table 13-10 of NAVFAC DM-5 for month and latitude of activity.
3. In case of excessive rainfall monthly allowance is zero.
4. Divide allowance in Column 6 by 12 inches per foot to convert allowance to acre feet per acre for Column 7.
5. Col. 7: A = acres irrigated, AF = acres-feet of water allowance

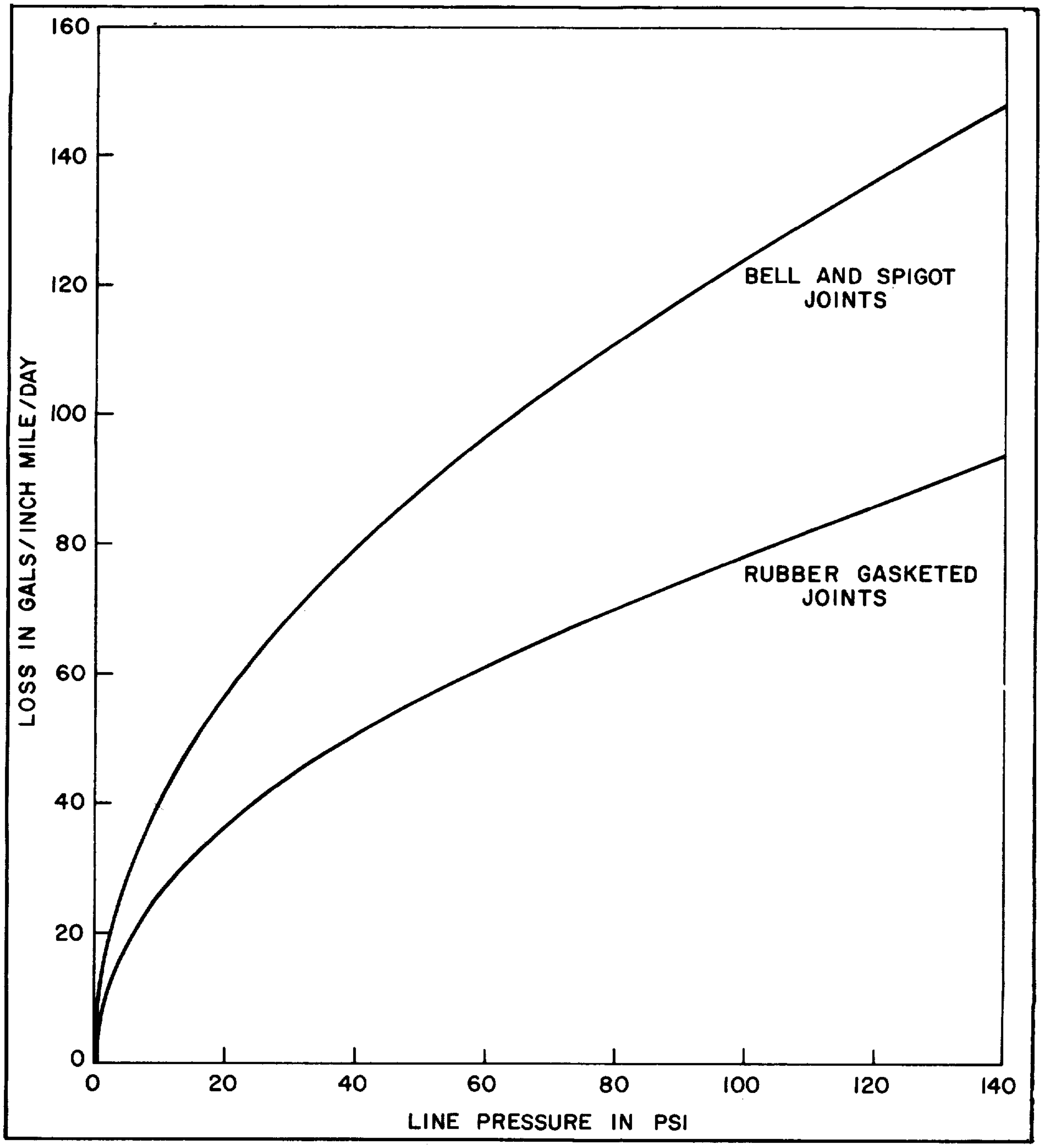
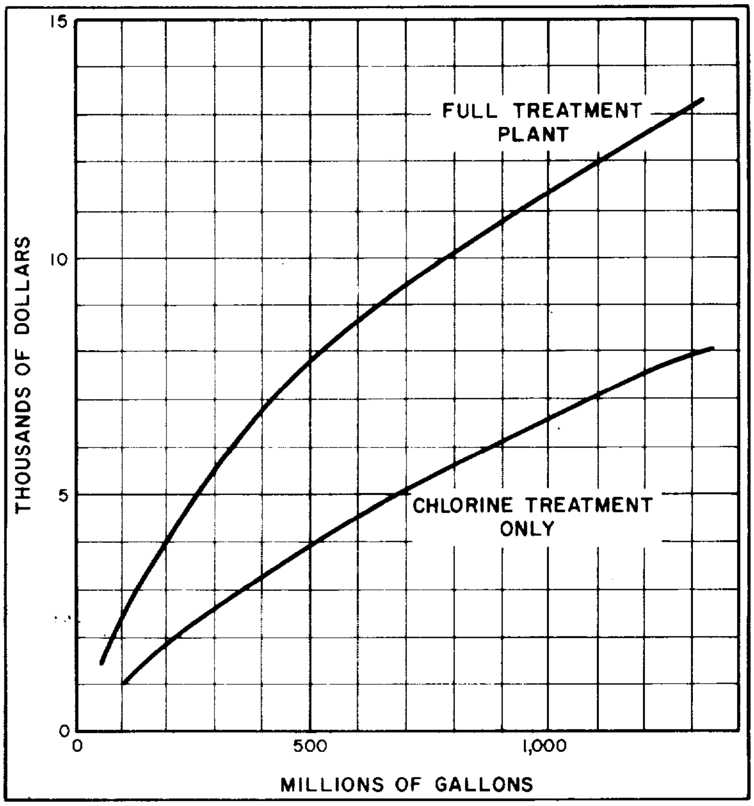



FIGURE 3-1
Line Loss as a Function of Pressure




NOTE: If the production plant is automated, cost values should be reduced to from 50 to 80 per cent, as dictated by the previous experience of the activity.

FIGURE 3-2
Annual Operation Cost Vs. Annual Production

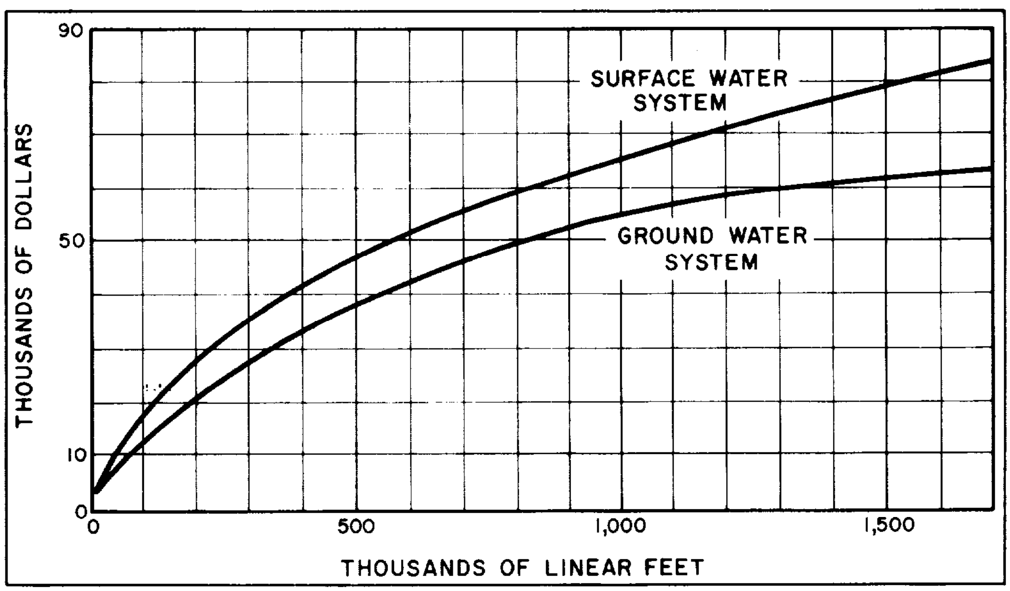



FIGURE 3-3
Annual Maintenance Cost Vs. Length of Distribution Mains

TABLE 3-8
Division of Operation and Maintenance Costs

Table A - Division of Operation Costs

| | Production | Distribution |
|---|---|---|
| Automated or non-automated . . . . . . . . . . . . . . | 90-95% | 5-10% |
| System with customer meters. . . . . . . . . . . . . . | 60-70% | 30-35% |

Table B - Division of Maintenance Cost

| | Full Treatment | | Chlorine Only | |
|---|---|---|---|---|
| Approximate Linear ft of Mains | Production | Distribution | Production | Distribution |
| 25,000 | 83% | 17% | 73% | 27% |
| 50,000 | 80 | 20 | 70 | 30 |
| 100,000 | 75 | 25 | 63 | 37 |
| 150,000 | 70 | 30 | 57 | 43 |
| 200,000 | 67 | 33 | 55 | 45 |
| 250,000 | 65 | 35 | 53 | 47 |
| Over 250,000 | 64 | 36 | 52 | 48 |

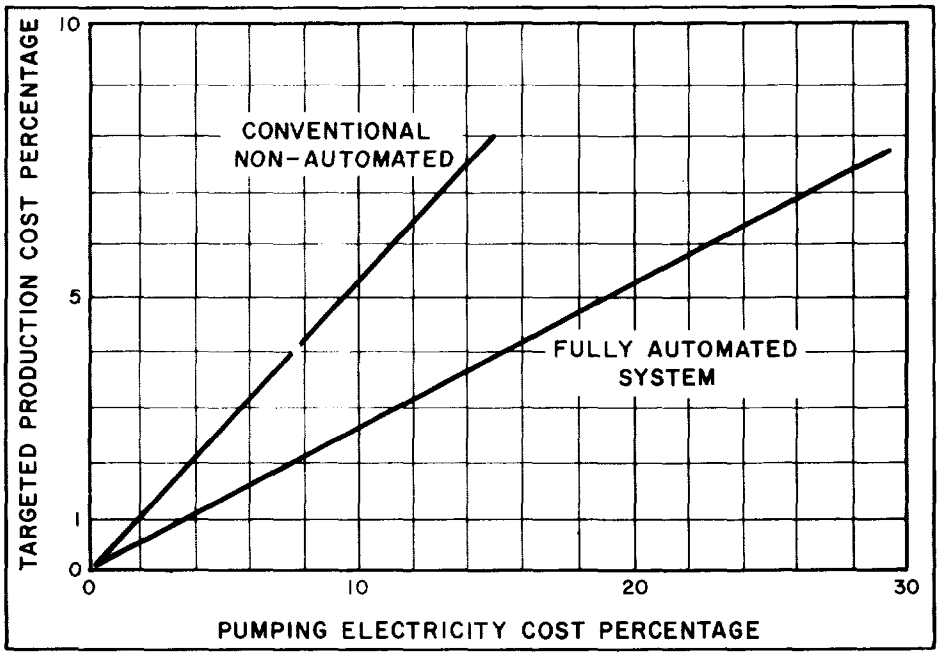



FIGURE 3-4
Total Production Cost Percentage Vs. Pumping Electricity Cost Percentage

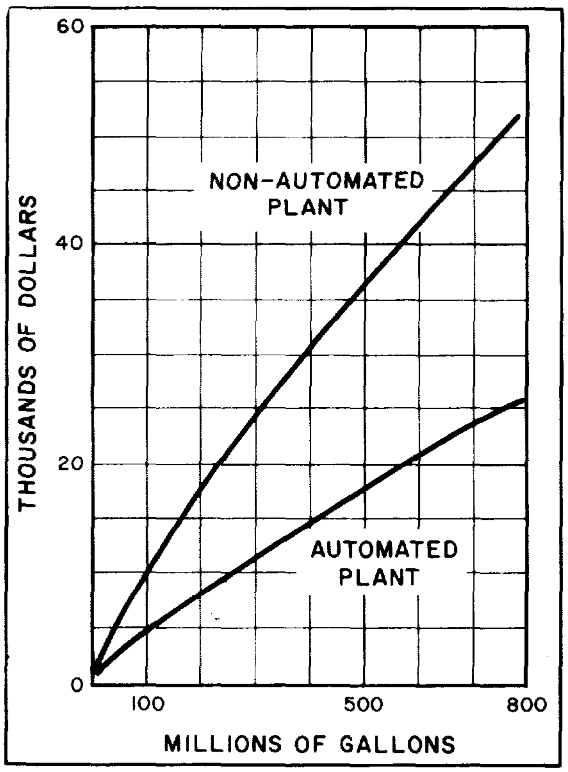



FIGURE 3-5
Total Production Operating Cost Vs. Annual Purchases

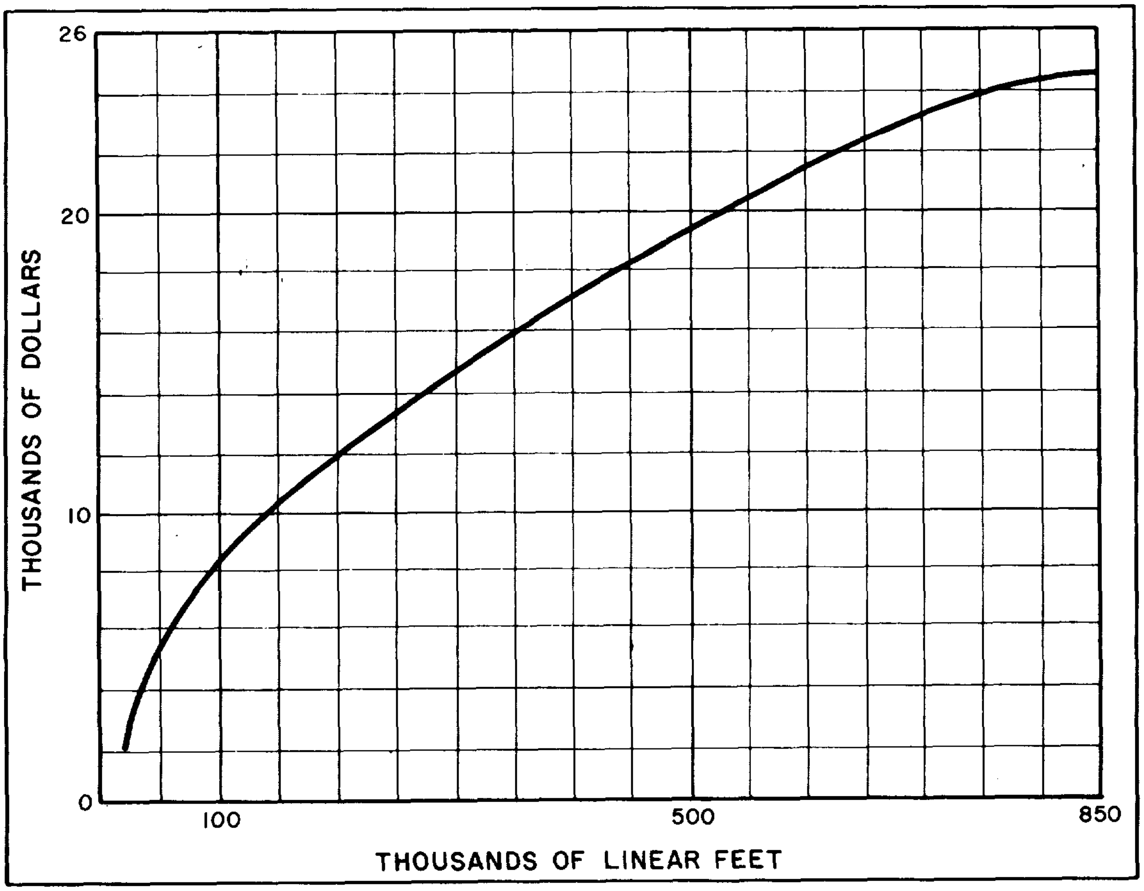



FIGURE 3-6
Total Production Maintenance Cost Vs. Length of Distribution Mains

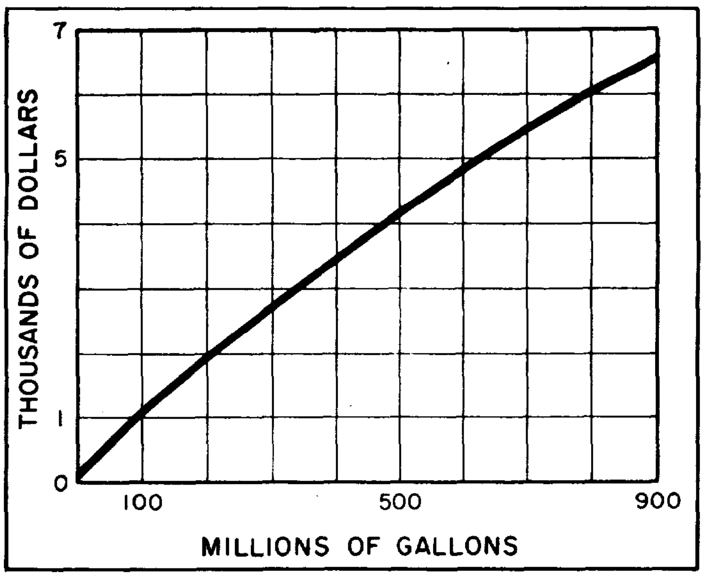



FIGURE 3-7
Annual Distribution Operation Cost Vs. Annual Purchases

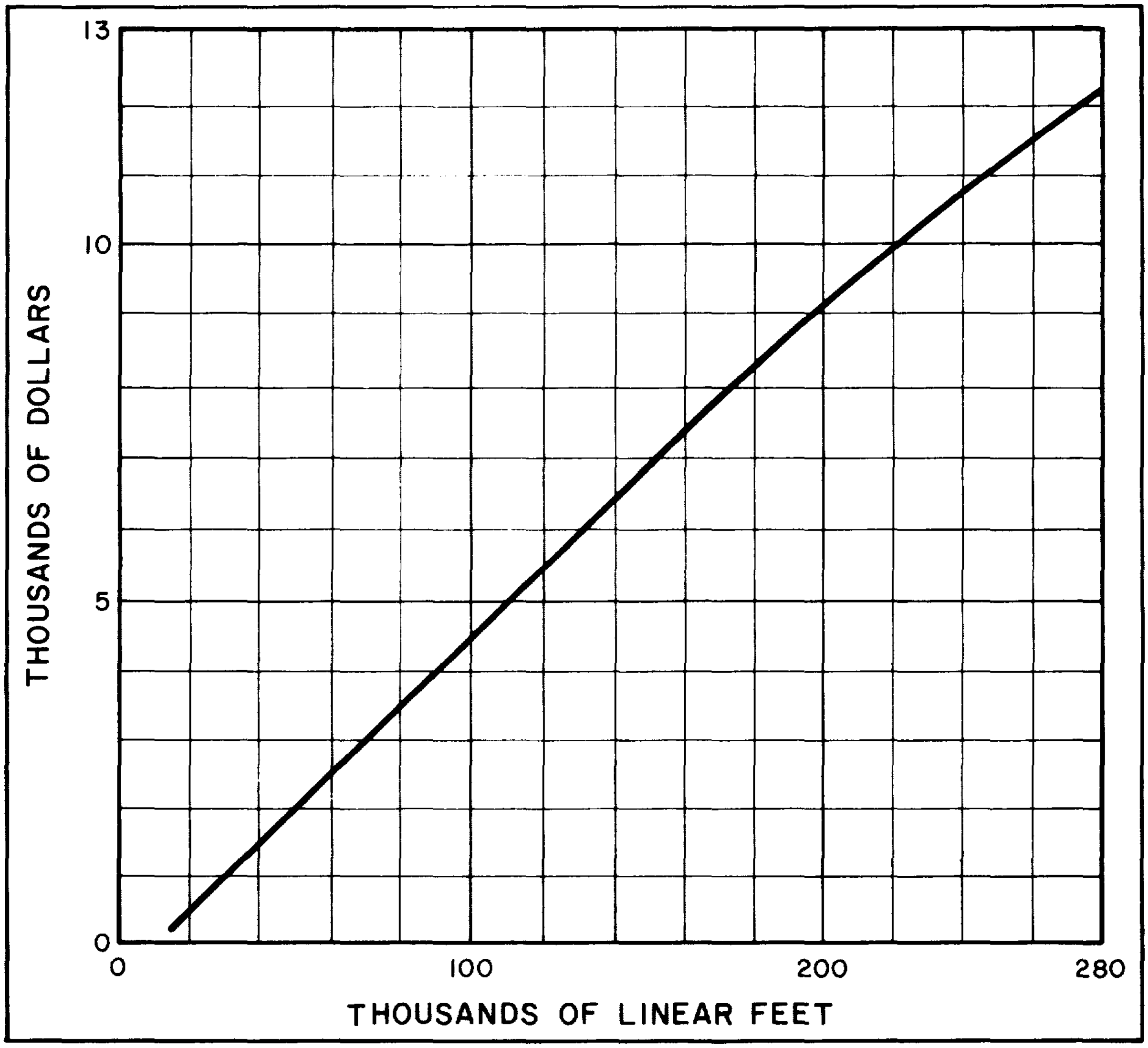



FIGURE 3-8
Annual Distribution Maintenance Vs. Length of Distribution Mains

## CHAPTER 4. TARGETS FOR STEAM, HEAT AND FUEL

4.1 GENERAL. Steam, heat and fuel targets are estimates of the quantities of these utilities that a Naval shore activity should be using and of what the respective unit costs of these utilities should be. The targets are developed and maintained by the EFD under the assumption that all practical conservation measures are in effect. Steam, heat and fuel constitute a large part of the utilities budget for most activities; the targets for these utilities should therefore be especially detailed and should be calculated at least twice a year. The steam and heat quantity includes the following elements:

Building heating.
Domestic use (primarily water heating).
Process or industrial use.
Interutility transfer (for example, steam generation of electricity.
Steam used in production.
Distribution losses, excluding avoidable loss and leakage.
Reimbursable distribution.
Special uses not covered under any of the above categories.
These uses will vary according to the mission of the activity.

4.2 WEATHER DATA. One of the prime factors in determining steam, heat and fuel targets is the weather. For the purpose of heating, this may be expressed by: winter design temperature, which is, essentially, how cold it gets in a given region, and degree days, which indicates the length of the heating season.

4.2.1 Winter Design Temperature. This is the temperature, in degrees Fahrenheit, to which, or below which, the outside temperature falls for 2 1/2 percent of the target period. These values are found in NAVFAC P-89, Engineering Weather Data Book; or if they are not available in P-89 for a given locale, they may be found in handbooks of heating, ventilating and air conditioning.

4.2.2 Degree Days. This is an index of the amount of heat or fuel required during a 24 hour day. The number of degree-days per day is the difference between the degree day base and the daily mean temperature, when this value is below the base. Degree-day base for buildings in which personnel are normally working or living is defined as 65°F. These include offices, barracks, schools, etc. For buildings which must be heated, but where personnel are not ordinarily working, or where such heating would not be economically sound, 55°F. is taken as the degree-day base. These would include such buildings as large shops, warehouses, or unoccupied buildings where heating is absolutely necessary.

Degree-day data should be based on actual day-to-day readings. The data for the target period can be obtained from the activity's weather records, local weather records, local weather bureau, or U.S. Weather Bureau. Degree-day records are also maintained by local utility and heating fuel companies.

4.2.3 Special Cases. There are special cases where the normal method of computing degree days will not reflect the true heating requirements of the activity. Some examples are desert areas in California and the Florida coast in winter. In these areas the daytime high temperature offsets the nighttime low, causing the median to fall above 65°F., yet heating is required at night. In these cases the degree day should be based on the median of the coldest six hours in the day. One quarter of the resulting degree day should be used in establishing the target.

4.3 BUILDING HEATING ALLOWANCE. Each building heating target, in B.t.u.'s per degree day, is the product of volume and heating allowance, using all applicable correction factors. The total activity heating target is obtained by adding the allowance for each building and multiplying the sum by the total number of degree days in the target period. Table 4-5 is a form suggested for listing and targeting all buildings heated by the activity steam plant. The heating allowance per degree day is estimated by using such a chart in conjunction with Tables 4-8 and 4-10, and Figure 4-1. Table 4-8 shows heat allowances for buildings of various types, according to construction and function. The tables take into consideration outside design temperature, inside design temperature and the degree day basis on which the allowance is based. These allowances assume a window area of 20 to 50 percent of gross wall area on A-type buildings and 25 to 30 percent on B-type buildings. An allowance factor should be established for buildings which differ appreciably from these configurations.

These allowances are based only on the volume of the space to be heated. However, other factors to be considered are:

4.3.1 Building Shape. The ratio of wall area to roof area is a factor to be considered. This factor changes considerably with building height, as shown in Figure 4-1.

4.3.2 Wind Velocity. The surface conductance of a structure increases with wind velocity, and the allowances above assume an average wind velocity of 15 m.p.h. For values which average consistently above or below 15 m.p.h., Table 4-9 may be used to determine a correction factor.

4.3.3 Special Cases. Buildings which have unusual ventilation requirements — paint shops, mess halls, etc. — are special cases. Heating requirements for this type of building may be determined by the equation:

$$H = 0.24\ (t_i - t_o)NV\ (d), \tag{4-1}$$

where: $H$ = heat required, B.t.u./hr.,
$d$ = air density (normally 0.075 lb./cu. ft.),
$N$ = number of air changes per hour,
$V$ = volume (cu. ft.),
$t_i$ = inside design temperature, and
$t_o$ = outside design temperature.

Assuming normal air density, this formula can be simplified to:

$$H = \frac{(t_i - t_o)NV}{55} \tag{4-2}$$

Air change requirements (N) can be obtained from standard heating and air conditioning handbooks. Some typical change requirements for buildings in use are:

1 to 1 1/2 charges/hr. for barracks, administration, residences
2 to 3 for industrial buildings
4 to 6 for mess halls, auditoriums, churches
6 for garages, general prison quarters
2,100 - 4,500 c.f.h. for hospital wards
2,000 c.f.h. per occupant for classrooms.

4.4 DOMESTIC WATER HEATING REQUIREMENTS. The allowance for domestic water heating for areas served by the targeted utility is $10^6$ (one million) B.t.u./30-day period per person for residents, and 2.5 X $10^6$ B.t.u./30-day period per person for hospital bed patients. The resident total is the sum of full time residents and the equivalent sum of part time residents. (A person working basically one shift per day is counted as 1/4 of a person, unless he is also a resident in an area served by the utility.) Galley allowance of steam per meal may be averaged on the basis of the mess hall capacity, as follows:

| Capacity mess hall | Average steam required (Btu/man/meal) |
|---|---|
| 300 persons | 5,700 |
| 500 persons | 5,400 |
| 1,000 persons | 4,900 |
| 2,000 persons | 4,400 |
| 3,000 persons | 3,900 |
| 5,300 persons | 3,200 |

4.5 DISTRIBUTION LOSS. Distribution loss is the amount of heat normally radiated by the distribution system. Allowance should not be made in the target for avoidable loss or for loss within a targeted building. Those buildings heated by gas or electricity should be included in the targets for those utilities. Gas main line B.t.u. losses should be one-half of one percent and the heating target calculation should include the B.t.u. heating value of that loss; higher losses will occur in high-pressure and

and larger, longer and/or older mains. Note: When gas line losses exceed two percent, a leak survey should be performed.

Table 4-6 is an example of a chart which may be used to estimate steam distribution losses, using the factors given in Table 4-10 and Figure 4-2, where applicable. Total wind factor, Figure 4-2, for example, does not apply to portions of pipe runs which are underground or otherwise protected. The heat loss, B.t.u./hr., for each pipe size is the product of the length (feet), heat loss allowable (B.t.u./hr./ft.), temperature factor and air velocity factor if applicable. The total distribution line loss is the sum of the losses for all pipe sizes (B.t.u.) multiplied by the number of hours in the target period.

4.6 INDUSTRIAL LOAD. Industrial load includes all heat required for production, process and air conditioning use, including that supplied to ships, laundries, garbage treatment facilities, etc. Meters should be installed whenever it is practical, since this will identify the more efficient users and indicate areas where savings can be effected.

Table 4-1 is a work sheet which can be used to establish process and industrial steam and heat target allowances. It should contain data such as actual metered quantities delivered, information derived from manufacturer's equipment specifications and from standard steam turbine generator curves, one example of which is shown on Figure 2-5. The following may be used for estimating needs of various facilities:

Steam Cleaning: See steam cleaning use in Figure 4-4.
Laundries: 800 B.t.u.'s per pound of laundry, or as shown in Table 4-25.
Garbage treatment: 240 B.t.u.'s per pound per hour, at 212°F.
Ships in port: Steam requirements are shown in Table 4-11.
Hospital equipments: Steam requirements are shown in Table 4-22.

In determining a target allowance, actual temperatures for the target period and percentage of ships' complement actually berthed on the ships should be considered.

4.7 REIMBURSABLES. Reimbursables are quantities of utilities delivered which are not included in the target as such, but which must be included in the estimate of total production. These include interutility transfers and quantities delivered to other activities such as officers' mess, Navy exchange, ships, housing or commissary.

Interutility transfers may return some portion of the steam delivered to them. For example, a turbo-generator discharging to the atmosphere is charged with the total heat value delivered. A straight condensing unit which returns condensate into the cycle is charged only the difference in enthalpy between the delivered steam and the returned condensate. A back pressure or extraction unit which returns extracted steam to the original or a third utility is charged only for the difference in heat value between main and extracted steam. This condensate and extracted steam are charged to the ultimate user.

Tables 4-2 and 4-4 provide a work sheet format for determining the total quantity of steam, heat and fuel allowed for the target period, and for a comparison with quantity actually produced or purchased during the period.

4.8 PRODUCTION ALLOWANCES. Allowances must be made for the amount of heat used in producing the steam. The following percentages of boiler plant production may be used for the purpose of estimation:

| Operation | Quantity used |
|---|---|
| Intermittent blow-down | 1/2% - 1% |
| Soot-blowing - oil fired | 1% |
| Soot-blowing - coal fired | 2% |
| Steam atomization | 1-1 1/2% or 10% of fuel oil |
| Fuel oil heating | 1/2-3/4% or 0.07 lb steam/lb oil approx. |
| Combustion air heating | 2 1/2% |
| Radiation and unaccounted loss | 1% |
| Feedwater heating | depends on cycle design |
| Banking and start-up | 1 - 2% |

Steam atomization is required only on oil-fired units. Fuel oil heating percentage is based on No. 6 oil; Navy special or No. 2 oil may or may not require heating. Heating of combustion air is required only on units equipped with preheaters, and only during periods when low ambient temperatures require it. Banking and start-up percentages need only be taken into account when the unit is frequently shut down, or banked for extended periods.

Percentage for feedwater heating may be computed from the formula:

$$\% = \frac{F-C}{S-C} \times 100^{1},$$

where F = B.t.u./lb. heat content of water (average temp. of water minus 32°F.),
C = B.t.u./lb. heat content of condensate (average temp. of condensate in return-line minus 32°F.), and
S = heat content of steam based on boiler pressure and temperature conditions.

Enthalpy in B.t.u. per pound may be determined from standard texts — for example, Keenan and Keyes, Table of Thermodynamic Properties of Steam —or from Table 4-12.

This formula applies to those systems in which the heat value of steam is completely utilized. These include open type heater (deaerator) or closed type heater with heater drains returned to the cycle. For closed

[1] A more precise formula is $\frac{\text{lb.F} - \text{lb.C}}{\text{lb.S} - \text{lb.F}} = a$; % steam $= \frac{a}{1 + a} \times 100$.

heater installations which do not return the heater drains to the feed-water cycle, the formula may be modified as follows:

$$\% = \frac{F-C}{S-D} \times 100$$

where D = heat content of heater drains in B.t.u./lb.

The total percentage of steam required of production is the sum of all percentages above which apply to a particular system. The amount of steam used is found by multiplying gross plant output by this percentage expressed as a decimal. The gross plant production target, with x percent of the gross output required for production, and a net plant production target, Tn, is:

$$Tg = Tn \div \frac{100-x}{100} .$$

4.9 BOILER EFFICIENCY. The efficiency of a boiler or system is the ratio of the gross heat output to the gross heat input. Gross heat output is entered on line 1 of the UCAR, and is the heat content of the gross plant output less the heat content of the boiler feedwater. The heat input is entered on line 15 of the UCAR, and is the heat value of the total fuel consumed. The boiler efficiency target is based on optimum operating conditions. It is the manufacturer's design efficiency, modified to reflect the age and operating condition of the boiler.

The boiler efficiency target can be calculated by multiplying the actual boiler operating efficiency by the target plant ratio. The target ratio is established by the Engineering Field Division engineers in consultation with the plant technical operating engineers, considering the plant's original design efficiency and its present condition.

Boiler efficiency may be determined through the use of a combustion analyzer: for example, the "Bailey Heat Prover and Combustion Analyzer," which measures the amount of unburned combustibles in the flue gases. This data can be compared with the amount of fuel used to give an estimate of preventable fuel loss. Tables 4-13 through 4-16 show examples of boiler data required to establish boiler targets.

4.10 FUEL QUANTITY TARGET. The fuel quantity target for any equipment is the gross heat output divided by the efficiency target at average loading conditions during the target period. The ratio of fuel quantity target and the fuel actually used is another method of estimating the target plant ratio and to identify areas in which significant cost reduction can be realized. Figure 4-3 gives heat values in B.t.u./unit of fuel and curves for converting gallons of fuel at varying temperatures to standard gallons at 60°F.

4.11 UNIT COST TARGETS. Unit Cost Targets for steam, heat, and fuel shall be developed for the quantities produced or delivered. The cost targets are defined as the average cost per million B.t.u. of heat value which can be attained under optimum conditions. These conditions of operation are difficult to achieve, and targets which assume these conditions will tend to engender a cost-conscious attitude. All factors of production should be considered factors of these targets: distribution, maintanance, overhead, and the effects of interutility transfers. The maintenance factor should be based on the long-term average cost at similar installations and should not be based on any unusually high costs due to special conditions. Unusual high costs should not be included in target data; rather they should be reported in the UCAR to pinpoint high actual costs.

Table 4-3 is a sample work sheet which outlines steps to be taken in establishing a unit cost target. As many items of production and distribution cost as possible should be included in this procedure. Additional data can be obtained from tables or curves of historical data. Tables 4-17, 4-18, and 4-19 are tables from which maintenance costs can be estimated for systems burning the three major fuels. The unit cost target delivered is developed for the steam heat utility services which are either produced or purchased, or both. Tables 4-20 and 4-21 show average annual maintenance costs for steam and gas distribution systems and may be used to develop the maintenance target. Quarterly distribution maintenance factor and target are developed as described in a previous paragraph.

TABLE 4-1
Sample Process and Industrial Steam/Heat/Fuel Usage Target Work Sheet

| BUILDING | EQUIPMENT | HEAT USE RATE ALLOWANCE | TOTAL HEAT USED IN TARGET PERIOD |
| --- | --- | --- | --- |
| | | | |

TABLE 4-2
Sample Steam-Heat-Fuel Quantity Target Summary

Activity_____________ Period ____Quarter, FY19__ By_________________

Date______________

1. Building Heating (Tables 4-5, 4-7 and 4-27, Item A-2)

| °F Basis | Allowance Btu/DD | Degree Days in Period |
|---|---|---|
| 65 | | |
| 55 | | |

Building Target

TARGET - $10^6$ Btu

2. Domestic Water Heating (Table 4-27 sample, Item A-3)

| Equivalent Residents | Allowance/person/ 30 Day | No. of 30 Day Periods |
|---|---|---|
| Full Time | $1.0 \times 10^6$ Btu | |
| Part Time[1] | $0.25 \times 10^6$ Btu | |
| Hospital | $2.5 \times 10^6$ Btu | |

Domestic Target

3. Distribution Loss (Table 4-27 sample, Item A-4)

4. Galley Allowance (Table 4-27 sample, Item A-5)

5. Reimbursables (Table 4-27 sample, Item A-6)

6. Industrial (Table 4-27 sample, Item A-7)

7. Interutility Transfer (Table 4-27 sample, Item A-8)

8. Total Heat System Produced and Purchased Quantity Target (Total of Items 1 thru 7) Enter in Line 7, UCAR

9. Total Net Production and Purchase (From Line 6, UCAR)

10. Variance

$$\% \text{ over target} = \frac{\text{Item 9-Item 8}}{\text{Item 8}} \times 100 = \frac{\qquad}{\qquad} \times 100 = \quad \%$$

$$\% \text{ under target} = \frac{\text{Item 8 - Item 9}}{\text{Item 8}} \times 100 = \frac{\qquad}{\qquad} \times 100 = \quad \%$$

[1]Part-time allowance = 1/4 full-time allowance

TABLE 4-3
Sample Delivered Steam/Heat Unit Cost Target Work Sheet

PERIOD TARGETED ______

| | | |
|---|---|---|
| I. | Production Costs | |
| | 1. Targeted Cost of Production<br>(From Item V of Table 4-4) | $ ______ |
| II. | Interutility Transfer Costs | |
| | 2. Actual Interutility Transfer Cost to Other Utilities<br>(This is to be subtracted From Other Costs) | $ ______ |
| III. | Purchased Costs | |
| | 3. Purchased Steam Costs, Intra-Navy (From Line 33, UCAR) | $ ______ |
| | 4. Purchased Steam Costs, Other (From Line 34, UCAR) | $ ______ |
| IV. | Distribution Operations Cost | |
| | 5. Labor Costs (From Line 36, UCAR) | $ ______ |
| | 6. Material Costs (From Line 37, (UCAR) | $ ______ |
| | 7. Contractural and Other Costs (From Line 38, UCAR) | $ ______ |
| V. | Distribution Overhead Costs | |
| | 8. Apportioned General Plant Expense (From Line 42, UCAR) | $ ______ |
| | 9. General Expense Applied (NIF) (From Line 43, UCAR) | $ ______ |
| VI. | Distribution Target Maintenance Costs | |
| | a. Inch-feet of Distribution Supply Main ______<br>b. Yearly Target Maintenance cost/inch-foot<br>(From Table 4-20) ______<br>c. Target Period Subdivision Factor ______<br>(Obtained from actual average maintenance costs for 3 previous years, as follows:<br>$\frac{\text{Av. Maint. Costs for Same Period, 3 Past FY}}{\text{Av. Total Maint. Costs, 3 Past FY}}$ | |
| | 10. Distribution Target Maintenance Cost (a $\times$ b $\times$ c) | $ ______ |
| VII. | Unit Cost Target | |
| | 11. Total Delivered Cost Target (Sum of Items 1 - 2 + 3 thru 10) | $ ______ |
| | 12. Actual Net Delivered Quantity ($10^6$ Btu) For Target Period.<br>(From Line 11, UCAR) | ______ |
| | 13. Unit Cost Target Delivered (Line 11 $\div$ 12) Enter Line 47, UCAR | ______ ($/$10^6$ Btu) |

NOTE: Unless noted, costs are actual costs from NavCompt Form 2127.

## TABLE 4-4
## Produced Steam/Heat Unit Cost Target Work Sheet

| | | | PERIOD TARGETED |
|---|---|---|---|
| I. | Production Operation Cost | | |
| | 1. Labor Costs - From Line 17, UCAR | $________ | |
| | 2. Fuel Costs - From Line 18, UCAR $________ | | |
| | 3. Ratio of Actual Plant Efficiency to Target Plant Efficiency ________ | | |
| | 4. Target Fuel Costs (2 x 3) | $________ | |
| | 5. Material Costs - From Line 19, UCAR | $________ | |
| | 6. Contractual and Other Costs - From Line 20, UCAR | $________ | |
| | 7. Total Target Production Operation Cost (Sum of Items 1 + 4 + 5 + 6) | | $________ |
| II. | Production Maintenance Costs | | |
| | 8. Labor Cost - From Line 21, UCAR | $________ | |
| | 9. Material Cost - From Line 21, UCAR | $________ | |
| | 10. Contractual and Other Costs - From Line 23, UCAR | $________ | |
| | 11. Total Target Production Maintenance Costs (Sum of Items 8 + 9 + 10) | | $________ |
| III. | Production Overhead Costs | | |
| | 12. Apportioned General Plant Expense - From Line 24, UCAR | $________ | |
| | 13. General Expense Applied (NIF) - From Line 25, UCAR | $________ | |
| | 14. Total Production Overhead Costs (Sum of Items 12 + 13) (to) | | $________ |
| IV. | Production Interutility Transfer Costs | | |
| | 15. From Electricity to Plant, Targeted, From Line 27, UCAR | $________ | |
| | 16. From Water to Plant, Targeted - From Line 28, UCAR | $________ | |
| | 17. From Other Utilities to Plant, Targeted | $________ | |
| | 18. Ratio of Actual Plant Efficiency to Target Plant Efficiency | ________ | |
| | 19. Target Production Interutility Transfer Costs (Sum of Items 15 + 16 + 17, times 18) | | $________ |
| V. | Total Plant Production Cost Target (Sum of Items 7 + 11 + 14 + 19) | | $________ |
| VI. | Actual Net Plant Production Quantity for Target Period, From Line 3, UCAR | | ________ ($10^6$ Btu) |
| VII. | Unit Cost Target Produced (Item V + Item VI) to Line 49, UCAR | | $________ ($\$/10^6$ Btu) |

NOTE: 1. The target plant efficiency should be established in conjunction with the plant technical operating engineers by increasing the actual measured efficiency figure in accordance with the plant age, design efficiency and individual operating conditions. This increase in efficiency will usually be in the area of 4% to 6%. Actual plant efficiency for the period can be obtained by procedures in Exhibit 4-19.

2. Unless noted, costs are actual costs from NavCompt Form 2127.

## TABLE 4-5
## Sample Building Heating Target Information Form

BUILDING HEATING TARGET INFORMATION FORM (SAMPLE)

| ① Building | | ② | ③ | ④ | ⑤ | ⑥ | ⑦ | ⑧ | ⑨ | ⑩ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| No. | Use | Category Exhibit 4-8 | Volume $10^3$ cu ft | Wall Area $10^3$ sq ft | Roof Area $10^3$ sq ft | Area Ratio ④ / ⑤ | Building Height | Building Shape Correction Factor Exhibit 4-9 | Heat Allow. Btu/cu ft/DD Exhibit 4-8 15F | Heat Allowance $10^3$ Btu/DD ③ × ⑧ × ⑨ 65° | 55° |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

TABLE 4-6
Sample Piping Heat Loss Form

| (1) Pipe Size Nominal Inches | (2) Length ft | (3) Insulation a. above grnd b. below grnd | (4) Heat Loss Factor Table 4-10 | (5) Temp. Diff. | (6) Temp. Corr. Factor, Ex. 4-12, Bot. Curve | (7) Air Velocity Factor Figure 4-2, Top Curve | (8) Heat Loss Btu/hr (2)x(4)x(6)x(7) |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

TABLE 4-7
Degree Days Based on Known Maximum and Minimum Daily Temperatures

| Max. Temp. Plus Min. Temp. 24 hrs | Degree Days 65° F Basis | Degree Days 55° F Basis | Max. Temp. Plus Min. Temp. 24 hrs | Degree Days 65° F Basis | Degree Days 55° F Basis | Max. Temp. Plus Min. Temp. 24 hrs | Degree Days 65° F Basis | Degree Days 55° F Basis |
|---|---|---|---|---|---|---|---|---|
| 128 | 1 | 0 | 84 | 23 | 13 | 40 | 45 | 35 |
| 126 | 2 | 0 | 82 | 24 | 14 | 38 | 46 | 36 |
| 124 | 3 | 0 | 80 | 25 | 15 | 36 | 47 | 37 |
| 122 | 4 | 0 | 78 | 26 | 16 | 34 | 48 | 38 |
| 120 | 5 | 0 | 76 | 27 | 17 | 32 | 49 | 39 |
| 118 | 6 | 0 | 74 | 28 | 18 | 30 | 50 | 40 |
| 116 | 7 | 0 | 72 | 29 | 19 | 28 | 51 | 41 |
| 114 | 8 | 0 | 70 | 30 | 20 | 26 | 52 | 42 |
| 112 | 9 | 0 | 68 | 31 | 21 | 24 | 53 | 43 |
| 110 | 10 | 0 | 66 | 32 | 22 | 22 | 54 | 44 |
| 108 | 11 | 1 | 64 | 33 | 23 | 20 | 55 | 45 |
| 106 | 12 | 2 | 62 | 34 | 24 | 18 | 56 | 46 |
| 104 | 13 | 3 | 60 | 35 | 25 | 16 | 57 | 47 |
| 102 | 14 | 4 | 58 | 36 | 26 | 14 | 58 | 48 |
| 100 | 15 | 5 | 56 | 37 | 27 | 12 | 59 | 49 |
| 98 | 16 | 6 | 54 | 38 | 28 | 10 | 60 | 50 |
| 96 | 17 | 7 | 52 | 39 | 29 | 8 | 61 | 51 |
| 94 | 18 | 8 | 50 | 40 | 30 | 6 | 62 | 52 |
| 92 | 19 | 9 | 48 | 41 | 31 | 4 | 63 | 53 |
| 90 | 20 | 10 | 46 | 42 | 32 | 2 | 64 | 54 |
| 88 | 21 | 11 | 44 | 43 | 33 | 0 | 65 | 55 |
| 86 | 22 | 12 | 42 | 44 | 34 | | | |

Example:

Maximum temperature for the day. . . . . . 78°F
Minimum temperature for the day . . . . . . 36°F
Total. . . . . . . . . . . . . . . . . . . . .114°F
DD, from table, 65°F basis 8
DD, from table, 55°F basis 0

Check: $65°F - \frac{114°F}{2} = 65°F - 57°F = 8$ DD

NOTES: Degree days for 55°F basis can be determined by subtracting 10 from degree days for 65°F basis.

Total DD for a targeted period must be determined on a day to day basis; do not use average temperatures for the period.

## TABLE 4-8
## Heat Allowance for Buildings at Naval Shore Activities

| EXAMPLES | CATE-GORY | Inside Design Temp.* | Degree Day Basis | Btus allowed/cu ft of building volume/degree day | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | -25°F Design | -20°F Design | -15°F Design | -10°F Design | -5°F Design | 0°F Design | 5°F Design | 10°F Design | 15°F Design | 20°F Design | Plus 25°F and above |
| Barracks, admin. | A-1 | 70 | 65 | 1.31 | 1.32 | 1.34 | 1.37 | 1.40 | 1.43 | 1.47 | 1.52 | 1.57 | 1.62 | 1.70 |
| Bldgs., Classrooms | A-2 | | | 1.36 | 1.38 | 1.40 | 1.43 | 1.46 | 1.49 | 1.53 | 1.58 | 1.63 | 1.69 | 1.78 |
| Recr. Bldgs., Mess | A-3 | | | 1.42 | 1.44 | 1.46 | 1.49 | 1.52 | 1.55 | 1.60 | 1.65 | 1.70 | 1.76 | 1.85 |
| Halls, etc. | A-4 | | | 1.53 | 1.55 | 1.57 | 1.61 | 1.64 | 1.67 | 1.73 | 1.78 | 1.84 | 1.90 | 2.00 |
| | A-5 | | | 1.97 | 1.98 | 2.01 | 2.05 | 2.10 | 2.15 | 2.21 | 2.28 | 2.36 | 2.43 | 2.55 |
| Dwellings, converted | B-1 | 70 | 65 | 1.74 | 1.77 | 1.79 | 1.83 | 1.87 | 1.91 | 1.96 | 2.02 | 2.08 | 2.16 | 2.28 |
| Quarters, hospital | B-2 | | | 1.81 | 1.84 | 1.87 | 1.91 | 1.95 | 1.99 | 2.04 | 2.11 | 2.17 | 2.26 | 2.38 |
| wards, laboratories, | B-3 | | | 1.89 | 1.92 | 1.95 | 1.99 | 2.03 | 2.07 | 2.13 | 2.20 | 2.26 | 2.35 | 2.48 |
| instrument shops, | B-4 | | | 2.04 | 2.07 | 2.11 | 2.15 | 2.19 | 2.23 | 2.30 | 2.38 | 2.44 | 2.54 | 2.68 |
| precision machine shops, | B-5 | | | 2.61 | 2.66 | 2.69 | 2.75 | 2.81 | 2.87 | 2.94 | 3.03 | 3.12 | 3.24 | 3.42 |
| etc. | | | | | | | | | | | | | | |
| Operating rooms, | C-1 | 85 | 65 | 1.95 | 2.00 | 2.04 | 2.09 | 2.15 | 2.21 | 2.30 | 2.40 | 2.51 | 2.65 | 2.85 |
| Maternity Sections. | C-2 | | | 2.03 | 2.08 | 2.13 | 2.18 | 2.25 | 2.31 | 2.40 | 2.50 | 2.62 | 2.76 | 2.98 |
| Exam. rooms, special | C-3 | | | 2.12 | 2.17 | 2.22 | 2.27 | 2.34 | 2.41 | 2.50 | 2.61 | 2.73 | 2.88 | 3.10 |
| wards, special pro- | C-4 | | | 2.29 | 2.31 | 2.34 | 2.45 | 2.53 | 2.60 | 2.70 | 2.82 | 2.95 | 3.11 | 3.35 |
| cess rooms, etc. | C-5 | | | 2.92 | 3.00 | 3.06 | 3.14 | 3.23 | 3.31 | 3.45 | 3.60 | 3.76 | 3.98 | 4.27 |
| Shops, warehouses, | D-1 | 50 | 55 | 0.68 | 0.69 | 0.70 | 0.72 | 0.73 | 0.75 | 0.77 | 0.80 | 0.82 | 0.84 | 0.86 |
| Industrial Bldgs., | D-2 | to 60 | | 0.71 | 0.72 | 0.73 | 0.75 | 0.76 | 0.78 | 0.80 | 0.83 | 0.85 | 0.87 | 0.89 |
| galleys, hangars and | D-3 | | | 0.73 | 0.74 | 0.76 | 0.78 | 0.79 | 0.81 | 0.83 | 0.86 | 0.89 | 0.92 | 0.95 |
| heated unoccupied | D-4 | | | 0.80 | 0.81 | 0.82 | 0.84 | 0.85 | 0.88 | 0.90 | 0.94 | 0.96 | 0.98 | 1.00 |
| buildings where heating | D-5 | | | 1.02 | 1.04 | 1.06 | 1.08 | 1.10 | 1.12 | 1.15 | 1.20 | 1.23 | 1.26 | 1.29 |
| is absolutely essential | | | | | | | | | | | | | | |

Categories consist of a letter and a digit, viz: B-3

The letter denotes the type of building as shown and the digit denotes the approximate type of construction (to be altered to suit individual condition), as follows:

1. Fully insulated building (walls and ceiling), wall heat transfer coefficient of approximate U = .10.

2. Partially insulated building (1 or 2 inch in walls or ceiling), wall heat transfer coefficient of approximately U = .18.

3. Standard structure, no insulation (wood sheathing, siding, and stud space, lath and plaster; brick veneer; tile or block with furred plaster) wall heat transfer coefficient of approximately U = .25.

4. Masonry structure, and no interior furred walls - wall heat transfer coefficient of approximately U = .40.

5. Skin Type Structure - bare metal exterior wall or bare sheathing wall, no interior wall; wall heat transfer coefficient of about U = 1.0.

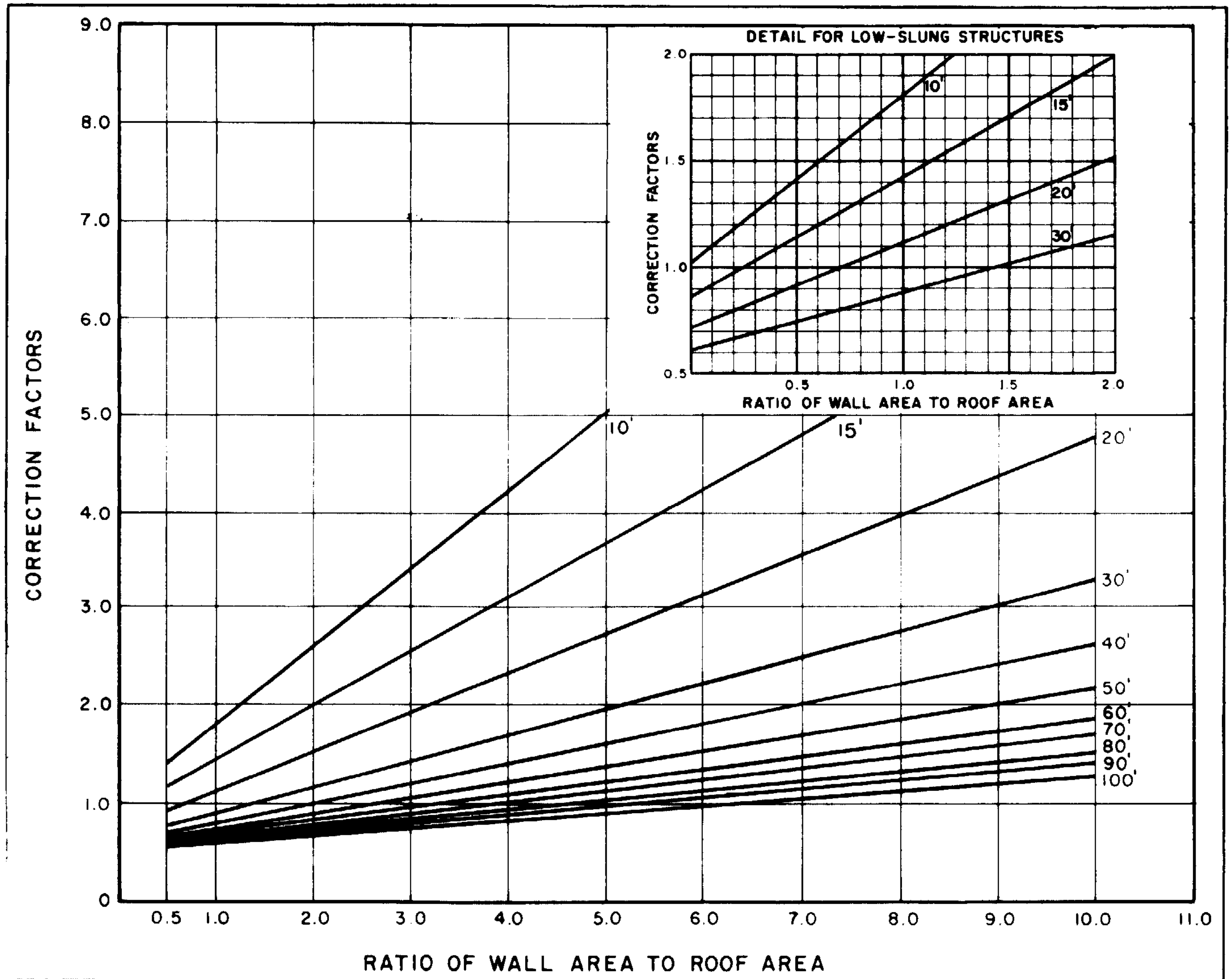



FIGURE 4-1
Building Shape Correction Factor
Wall Area/Roof Area Vs. Correction Factors for Various Building Heights

TABLE 4-9 (1 of 2)
Effect of Wind Velocity

| Wind Velocity mph | Value of $f_x$ |
|---|---|
| 0 | 1.46 |
| 5 | 3.20 |
| 7 1/2 | 4.00 |
| 10 | 4.60 |
| 15 | 6.00 |
| 20 | 7.30 |
| 25 | 8.60 |
| 30 | 10.00 |

$$U_x = \frac{1}{\frac{1}{f_x} + \left(\frac{1}{U_{15}} - 0.17\right)}$$

where $U_x$ = U value at wind velocity x, in Btu/hr/sq ft/°F diff

$U_{15}$ = U value at 15 mph

fx = outside surface conductance at velocity x

For example - building with U value of 0.40 at 15 mph outside, find U for a 30 - mile wind

$$U_x = \frac{1}{\frac{1}{10.00} + \left(\frac{1}{0.40} - 0.17\right)}$$

$$= \frac{1}{0.1 + 2.5 - 0.17} = \frac{1}{2.43} = 0.412$$

The correction factor is approximated by $\frac{U_x}{U_{15}}$. Multiply this factor by the building allowance, Table 4-8. In the above example, the factor is:

$$\frac{0.412}{0.400} = 1.03$$

The following table provides the correction factor for wind velocities from 0 to 30 mph eliminating the need for repetitive calculations.

TABLE 4-9 (2 of 2)
Effect of Wind Velocity (Correction Factors)

| Wall "U" | Wind Vel. MPH | Adjusted "U" | Correction Faction for Wind Velocity |
|---|---|---|---|
| .1 | 0 | .095 | 0.95 |
| | 15 | .10 | 1.00 |
| | 30 | .101 | 1.01 |
| .2 | 0 | .18 | 0.91 |
| | 15 | .20 | 1.00 |
| | 30 | .202 | 1.01 |
| .3 | 0 | .26 | 0.87 |
| | 15 | .30 | 1.00 |
| | 30 | .412 | 1.02 |
| .4 | 0 | .33 | 0.83 |
| | 15 | .40 | 1.00 |
| | 30 | .307 | 1.03 |
| .5 | 0 | .398 | 0.80 |
| | 15 | .50 | 1.00 |
| | 30 | .518 | 1.04 |
| .6 | 0 | .46 | 0.77 |
| | 15 | .60 | 1.00 |
| | 30 | .625 | 1.04 |
| 1.0 | 0 | .66 | 0.66 |
| | 15 | 1.0 | 1.00 |
| | 30 | 1.08 | 1.08 |

TABLE 4-10
Piping Heat Loss Allowance (Btu/hr/ft)

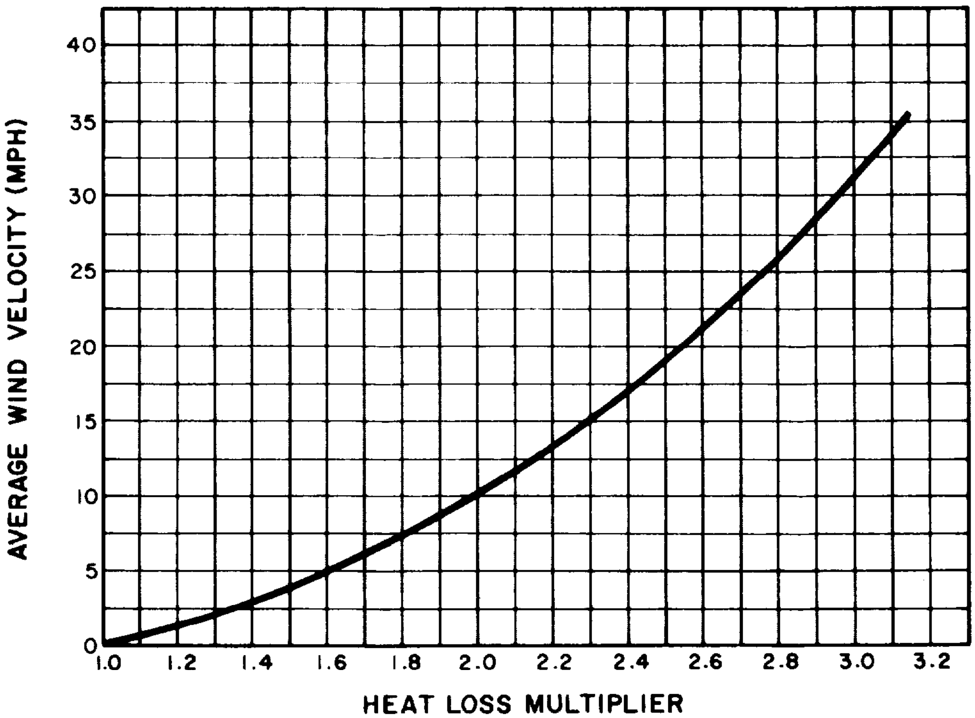
| Nominal Pipe Size Inches | INSULATION THICKNESS (Inches) BARE | 7/8(s) | 1 1/32(s) | 1 1/8(s) | 1 1/4(s) | 1 1/2(s) | 2 | 2 5/32(ds) | 2 1/4(ds) | 2 1/2(ds) | 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/2 | 230 | 52 | | | | 41 | 36 | | | 33 | 31 |
| 1 | 400 | 68 | | | | 52 | 45 | | | 41 | 38 |
| 1 1/2 | 570 | 87 | | | | 64 | 55 | | | 49 | 45 |
| 2 | 730 | | 92 | | | 74 | 63 | 61 | | 56 | 51 |
| 3 | 1,060 | | 123 | | | 97 | 81 | 77 | | 71 | 64 |
| 4 | 1,360 | | | 141 | | 116 | 96 | | 89 | 84 | 75 |
| 5 | 1,660 | | | 170 | | 138 | 113 | | 104 | 98 | 86 |
| 6 | 2,000 | | | 195 | | 158 | 129 | | 117 | 111 | 98 |
| 8 | 2,600 | | | | 225 | 197 | 160 | | | 136 | 119 |
| 10 | 3,240 | | | | 272 | 238 | 192 | | | 162 | 141 |
| 12 | 3,870 | | | | | 276 | 221 | | | 187 | 159 |
| 14 | 4,500 | | | | | 301 | 239 | | | 213 | 175 |
| 16 | 5,130 | | | | | 339 | 270 | | | 238 | 196 |
| 18 | 5,760 | | | | | 378 | 300 | | | 264 | 216 |

Assumed 85% Magnesia, 300°F temp. diff., Still Air (0MPH)
(s) Standard Thickness, (ds) Double Standard

EXHIBIT 4-12

PIPING HEAT LOSS AIR VELOCITY AND TEMPERATURE CORRECTION CURVES

A. WIND VELOCITY CORRECTION FACTOR




B. PIPING HEAT LOSS TEMPERATURE CORRECTION FACTOR (BASED ON 300°F ΔT)

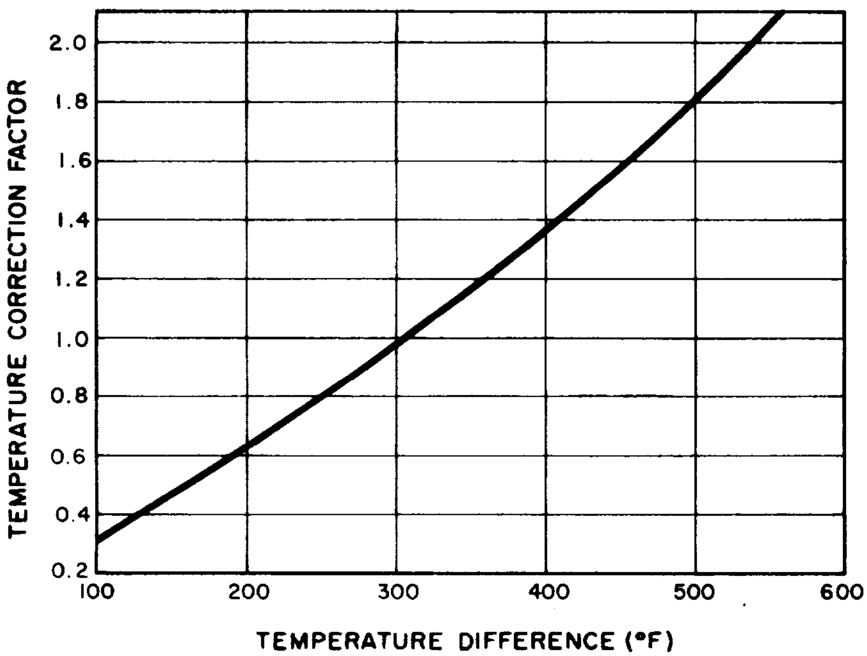



FIGURE 4-2
Piping Heat Loss Air Velocity and Temperature Correction Curves

TABLE 4-11
Steam Requirements for Ships in Port

| Vessel | | Steam Requirements at 150 psig ($10^6$ Btu/hr) | | |
|---|---|---|---|---|
| Type | Class | Intermittent for Heating | Constant, for galley, laundry, hot water | Total |
| Carriers | CVAN 65 | 25 | 25 | 50 |
| | CVA 59 | 15 | 23 | 38 |
| | CVA 63 | 19 | 25 | 44 |
| Cruisers | CAG 2 | 9 | 1.8 | 10.8 |
| Destroyers | DD 931 | 1.9 | 3.1 | 5 |
| | DLG 16 | 6.9 | 5.5 | 12.4 |
| Auxiliaries | AS 19 | 5 | 5 | 10 |
| Submarines | — | None | None | None |

Notes: 1. Heating requirements are based on +10°F outdoor temperature. Heat requirements will vary at warmer or colder temperatures.

2. These figures are generally maximum for ship type or class.

3. Constant steam requirements are based on full complement on board. Reduce according to percent of crew berthed ashore.

## TABLE 4-12
## Properties of Saturated Steam (Standard Barometer 14.696 psi)

| Gage Pressure lb/sq in | Temperature °F | Specific Volume $ft^3$/lb | Heat Btu/lb Liquid | Latent | Total |
|---|---|---|---|---|---|
| 0 | 212.00 | 26.800 | 180.07 | 970.3 | 1150.4 |
| 1 | 215.33 | 25.310 | 183.43 | 968.2 | 1151.6 |
| 2 | 218.50 | 28.800 | 186.61 | 966.2 | 1152.8 |
| 3 | 221.51 | 22.530 | 189.66 | 964.2 | 1153.9 |
| 4 | 224.39 | 21.400 | 192.56 | 962.3 | 1154.9 |
| 5 | 227.11 | 20.380 | 195.32 | 960.6 | 1155.0 |
| 6 | 229.80 | 19.460 | 198.01 | 958.9 | 1156.0 |
| 7 | 232.32 | 18.620 | 200.56 | 957.2 | 1157.8 |
| 8 | 231.76 | 17.853 | 203.04 | 955.6 | 1158.0 |
| 9 | 237.11 | 17.148 | 205.41 | 954.1 | 1159.5 |
| 10 | 239.39 | 16.496 | 207.72 | 952.6 | 1160.3 |
| 15 | 219.75 | 13.470 | 218.23 | 945.7 | 1163.9 |
| 20 | 258.76 | 11.999 | 227.38 | 939.6 | 1166.9 |
| 25 | 266.78 | 10.576 | 235.55 | 934.0 | 1169.6 |
| 30 | 274.02 | 9.438 | 242.95 | 929.0 | 1171.9 |
| 35 | 280.62 | 8.566 | 249.69 | 924.3 | 1174.0 |
| 40 | 286.71 | 7.826 | 257.99 | 918.4 | 1176.4 |
| 45 | 292.37 | 7.210 | 261.73 | 915.7 | 1177.4 |
| 50 | 297.66 | 6.685 | 267.18 | 911.9 | 1179.1 |
| 55 | 302.62 | 6.233 | 272.31 | 908.2 | 1180.5 |
| 60 | 307.32 | 5.839 | 277.14 | 904.6 | 1181.7 |
| 65 | 311.77 | 5.475 | 281.75 | 901.2 | 1183.0 |
| 70 | 316.00 | 5.185 | 286.13 | 898.0 | 1184.1 |
| 75 | 320.03 | 4.912 | 290.36 | 894.9 | 1185.3 |
| 80 | 323.90 | 4.665 | 294.34 | 891.9 | 1186.2 |
| 85 | 327.59 | 4.445 | 298.18 | 888.9 | 1187.1 |
| 90 | 331.15 | 4.211 | 301.88 | 886.1 | 1188.0 |
| 95 | 334.57 | 4.061 | 305.46 | 883.3 | 1188.8 |
| 100 | 337.88 | 3.892 | 308.91 | 880.7 | 1189.6 |
| 110 | 344.15 | 3.595 | 315.49 | 875.6 | 1191.1 |
| 120 | 350.01 | 3.339 | 321.67 | 870.7 | 1192.3 |
| 130 | 355.59 | 3.121 | 327.53 | 865.9 | 1193.4 |
| 140 | 360.84 | 2.927 | 333.07 | 861.5 | 1194.6 |
| 150 | 365.85 | 2.757 | 338.38 | 857.1 | 1195.6 |
| 160 | 370.62 | 2.607 | 343.44 | 853.0 | 1196.4 |
| 170 | 375.17 | 2.470 | 348.29 | 848.9 | 1197.2 |
| 180 | 379.54 | 2.348 | 352.95 | 845.0 | 1198.0 |
| 190 | 383.74 | 2.238 | 357.45 | 841.0 | 1198.5 |
| 200 | 387.78 | 2.137 | 361.78 | 837.5 | 1198.3 |
| 210 | 391.67 | 2.045 | 385.97 | 833.9 | 1199.0 |
| 220 | 395.43 | 1.9604 | 370.02 | 830.2 | 1200.2 |
| 230 | 398.99 | 1.8826 | 373.96 | 826.9 | 1200.9 |
| 240 | 402.60 | 1.8107 | 377.78 | 823.5 | 1201.3 |
| 250 | 406.01 | 1.7442 | 381.49 | 820.2 | 1201.7 |
| 260 | 409.33 | 1.8822 | 385.10 | 816.8 | 1201.9 |
| 270 | 412.55 | 1.6243 | 388.03 | 813.8 | 1202.4 |
| 280 | 415.70 | 1.5706 | 392.06 | 810.6 | 1202.7 |
| 290 | 418.73 | 1.6210 | 396.38 | 807.6 | 1203.0 |
| 300 | 421.71 | 1.4737 | 398.05 | 804.6 | 1203.2 |
| 320 | 427.46 | 1.3808 | 405.00 | 798.7 | 1203.7 |
| 340 | 432.96 | 1.3094 | 411.08 | 792.9 | 1204.0 |
| 360 | 438.22 | 1.2400 | 416.92 | 787.3 | 1204.2 |
| 380 | 443.26 | 1.1774 | 422.53 | 781.9 | 1204.4 |
| 400 | 448.12 | 1.1207 | 428.0 | 776.6 | 1204.6 |
| 420 | 452.79 | 1.0690 | 483.2 | 771.4 | 1204.6 |
| 440 | 457.32 | 1.0216 | 438.4 | 766.2 | 1204.8 |
| 460 | 461.68 | 0.9782 | 443.3 | 761.2 | 1204.5 |
| 480 | 465.90 | 0.9382 | 448.1 | 756.3 | 1204.4 |
| 500 | 469.99 | 0.9012 | 452.9 | 751.4 | 1204.3 |

TABLE 4-13
Data Used in Calculation of Boiler Efficiency, Plant Efficiency and Percent of Generated Steam Used in Production

| | |
|---|---|
| 1. | Boiler Pressure |
| 2. | Boiler Temperature |
| 3. | Pounds or Btu's of Steam Generated |
| 4. | Pounds or Btu's of Steam Exported |
| 5. | Average Feedwater Temperature |
| 6. | Pounds of Feedwater in period |
| 7. | Average Condensate Return Temperature |
| 8. | Pounds of Condensate Return in period |
| 9. | Average Make Up Water Temperature |
| 10. | Pounds of Make Up Water in period |
| 11. | Quantity of Fuel Burned in period |
| 12. | Unit Heat Content of Fuel |
| 13. | Per cent of Steam Generated used for: |
| | (a) blowdown |
| | (b) soot blowing |
| | (c) steam atomization |
| | (d) banking & start up |
| | (e) fuel oil heating, leaks, etc. |
| 14. | Manufacturers heat rate curves for major equipment |
| 15. | Actual measured combustion efficiency |

## TABLE 4-14
## Determination of Average Return Line Water Temperature or Deaerator Influent Temperature

$$\text{Average Return Line Temp} = \frac{(\%\ \text{Condensate})(\text{T Condensate}) + (\%\ \text{Makeup})(\text{T Makeup})}{100}$$

or

$$\frac{(\text{Weight of Condensate})(\text{Temp of Cond}) + (\text{Weight of Make Up})(\text{Temp of Make Up})}{(\text{Weight of Condensate} + \text{Weight of Make Up})}$$

Determination of Actual Average Plant Efficiency

$$\text{Plant Efficiency} = \frac{(\text{Steam Exported})(\text{Heat Content of Steam-Heat Cont of Return Line})}{(\text{Fuel Burned})(\text{Unit Heat Content of Fuel})}$$

Heat Content of Steam: Knowing Boiler Pressure and Temperature determine Corresponding Heat Content of Steam in Btu/lb from Steam Tables such as Keenan and Keyes or ASME.

Heat Content of Return = Weighted Average Return Line Temp minus 32° = Btu/lb

Example:

Boiler Pressure 110 psig, Boiler Temp 344°F

Weight of Condensate 4,252,500 lbs, or 75%

Temperature of Condensate = 150°F

Weight of Make Up 1,417,500 lbs, or 25%

Temperature of Make Up = 60°F

Steam Exported = 4,325,000 lbs

Fuel Burned = 45,000 gals No. 6 F.O.

Unit Heat Content of Fuel = 150,000 Btu/lb

$$\text{Average Return Line Temp} = 0.75 \times 150°\text{F} + 0.25 \times 65°\text{F}$$

$$= \frac{(4,252,500)(150°\text{F}) + (1,417,500\ \text{lbs})(60°\text{F})}{(4,252,500\ \text{lbs} + 1,417,500\ \text{lbs})}$$

$$= 130°\text{F}$$

Heat Content of Return Line = 127.5°F - 32 = 95.5 Btu/gal

$$\text{Actual Plant Efficiency} = \frac{(4,325,000\ \text{lbs})(1191.1\ \text{Btu/lb} - 95.5\ \text{Btu/lb})}{(45,000\ \text{gal})(150,000\ \text{Btu/gal})} \times 100 = 70.2\%$$

## TABLE 4-15
## Determination of Percent of Generated Steam Used in Production

### EXHIBIT 4-18

### DETERMINATION OF PERCENT OF GENERATED STEAM USED IN PRODUCTION

$$\text{Percent for Feedwater Heating} = \frac{\text{(Heat Cont of Fdwtr) - (Heat Cont of Return Line)}}{\text{(Heat Content of Steam - Heat Cont of Return Line}}$$

Heat Content of Steam: Knowing Boiler Pressure and Temperature determine Heat Content of Steam from Keenan and Keyes Table of Thermodynamic properties of Steam, ASME steam tables or other steam property tables.

Heat Content of Return: As determined in previous example.

Heat Content of Feedwater: As determined in previous example.

In addition to steam used to heat feedwater the following allowances should be made for the applicable uses of steam in the plant.

| | |
|---|---|
| Percent for Intermittent Blowdown | 1/2 - 1% |
| Percent for Soot Blowing (Oil Fired) | 1% |
| Percent for Soot Blowing (Coal Fired) | 2% |
| Percent for Steam Atomization | 1-1/2% |
| Percent for Banking and Start Up | 1 - 2% |
| Percent for Miscellaneous (Fuel Oil Heating leaks, radiation losses) | 1 - 2% |

Example:

Boiler Pressure 110 psig Boiler Temp 344°F
Ave. Feedwater Temp 221°F
Ave. Return Line Temp 130°F
Heat Content of Steam = 1191.1 Btu/lb
Heat Content of Feedwater = 189 Btu/lb
Heat Content of Return = 98 Btu/lb

$$\text{Percent for Feedwater Heating} = \frac{189 \text{ Btu/lb} - 98 \text{ Btu/lb}}{1191.1 \text{ Btu/lb} - 98 \text{ Btu/lb}} \times 100 = 8.3\%$$

| | |
|---|---|
| Percent for Intermittent Blowdown | = .5% |
| Percent for Soot Blowing (Oil Fired) | = 1.0% |
| Percent for Steam Atomization | = 1.5% |
| Percent for Miscellaneous | = 2.0% |
| Total Per Cent Used in Gen. | = 13.3% |

NOTE: See paragraph 4-8 for closed type heaters with drains not returned to cycle

TABLE 4-16
Determination of Actual Average Boiler Efficiency

$$\text{Boiler Efficiency} = \frac{(\text{Steam Generated}) \times (\text{Heat Content of Steam}) - (\text{Heat Content of Feed Water})}{(\text{Fuel Burned})\ (\text{Heat Content of Fuel})}$$

Heat Content of Steam: Knowing boiler pressure and temperature determine heat content of steam from Keenan and Keyes Table of Thermodynamic Properties of Steam, ASME or other steam property tables.

Heat Content of Feedwater = Temperature of Feedwater minus 32°F.

Example:

Boiler Pressure = 110 psig, Boiler Temperature = 344°F
Therefore Heat Content of Steam = 1191.1 Btu/lb

Boiler Feedwater Temperature = 221°F
Therefore Heat Content of Feedwater = 221 - 32 = 189 Btu/lb

Steam Generated = 5,400,000 lbs

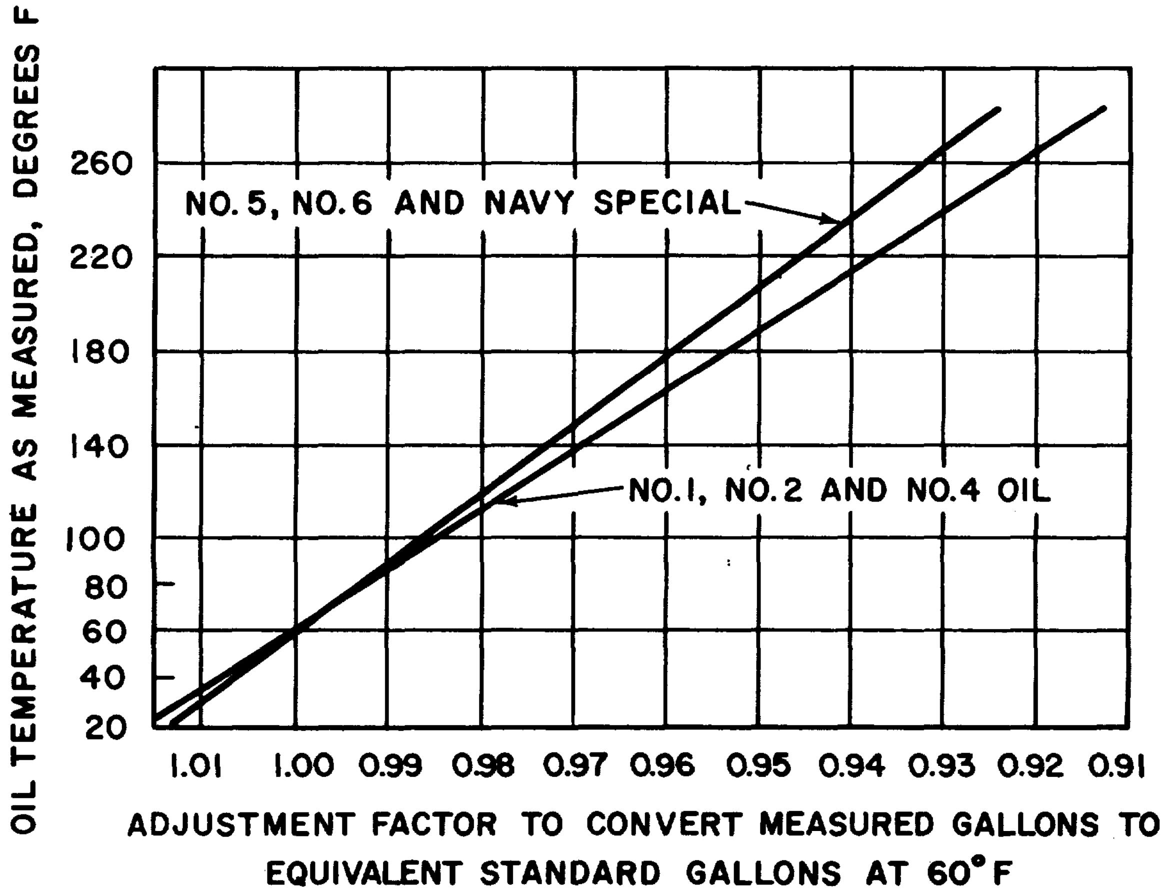
Fuel Burned = 45,000 Gallons No. 6

Heat Content of Fuel = 150,000 Btu/gal

$$\text{Actual Boiler Efficiency} = \frac{(5{,}400{,}000\ \text{lbs})\ (1191.1\ \text{Btu/lb} - 189\ \text{Btu/lb})}{(45{,}000\ \text{gal})\ (150{,}000\ \text{Btu/gal})} \times 100$$

$$= 80.2\%$$

EXHIBIT 4-20




| No. | Name | | Btu Per Gallon (gross) | Btu Per Pound (Gross) | Pounds Per Gallon |
|---|---|---|---|---|---|
| 1 | Distillate | | 136,000 | 19,650 | 6.9 |
| 2 | Domestic | | 139,000 | 19,500 | 7.1 |
| 4 | Commercial | | 145,000 | 19,200 | 7.6 |
| 5 | Residual | No Preheat | 148,000 | 19,000 | 7.8 |
| 5 | Residual | Preheat | 149,000 | 18,950 | 7.9 |
| 6 | Residual | Heavy | 152,000 | 18,800 | 8.1 |

FIGURE 4-3
Fuel Oil Conversion Graph and Fuel Oil Grades

## TABLE 4-17
## Gas Fired Annual Boiler Maintenance Cost

| Rated Boiler Capacity (× $10^3$ lb/hr)[1] | AGE OF BOILERS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 |
| 10 | 127 | 140 | 155 | 172 | 186 | 202 | 217 | 234 | 249 | 264 | 280 |
| 20 | 240 | 272 | 302 | 331 | 362 | 392 | 423 | 451 | 481 | 510 | 543 |
| 30 | 360 | 404 | 450 | 496 | 540 | 584 | 632 | 676 | 720 | 764 | 810 |
| 40 | 476 | 536 | 596 | 656 | 716 | 776 | 836 | 894 | 954 | 1012 | 1074 |
| 50 | 552 | 620 | 690 | 760 | 828 | 900 | 966 | 1036 | 1102 | 1172 | 1240 |
| 60 | 640 | 716 | 796 | 874 | 938 | 1036 | 1112 | 1192 | 1274 | 1350 | 1432 |
| 70 | 756 | 850 | 944 | 1040 | 1132 | 1230 | 1322 | 1420 | 1510 | 1608 | 1700 |
| 80 | 816 | 916 | 1020 | 1120 | 1224 | 1322 | 1428 | 1530 | 1632 | 1732 | 1836 |
| 90 | 965 | 1100 | 1240 | 1340 | 1450 | 1590 | 1720 | 1830 | 1940 | 2050 | 2170 |
| 100 | 1040 | 1170 | 1300 | 1430 | 1560 | 1700 | 1825 | 1960 | 2090 | 2180 | 2350 |
| 110 | 1120 | 1270 | 1410 | 1550 | 1680 | 1830 | 1970 | 2110 | 2220 | 2400 | 2540 |
| 120 | 1260 | 1380 | 1540 | 1690 | 1840 | 2000 | 2150 | 2300 | 2440 | 2600 | 2770 |
| 130 | 1880 | 2120 | 2360 | 2580 | 2820 | 3080 | 3320 | 3580 | 3780 | 4000 | 4250 |
| 140 | 2000 | 2260 | 2510 | 2760 | 3020 | 3280 | 3540 | 3800 | 4020 | 4270 | 4540 |
| 150 | 2060 | 2320 | 2580 | 2840 | 3100 | 3366 | 3600 | 3870 | 4150 | 4400 | 4660 |
| 160 | 2310 | 2610 | 2900 | 3270 | 3480 | 3710 | 4050 | 4300 | 4650 | 4960 | 5250 |
| 170 | 2370 | 2650 | 2960 | 3240 | 3540 | 3810 | 4100 | 4420 | 4730 | 5000 | 5300 |
| 180 | 2410 | 2700 | 2980 | 3320 | 3620 | 3910 | 4200 | 4500 | 4820 | 5100 | 5400 |
| 190 | 2430 | 2730 | 3020 | 3340 | 3650 | 3920 | 4240 | 4560 | 4860 | 5190 | 5500 |
| 200 | 2450 | 2760 | 3060 | 3370 | 3660 | 3960 | 4270 | 4570 | 4900 | 5200 | 5510 |

[1] If boiler is rated in Btu/hr, use $10^6$ Btu/hr = $10^3$ lb/hr. (This is an approximation, but close enough for this purpose.)

## TABLE 4-18
## Oil Fired Annual Boiler Maintenance Cost

| Rated Boiler Capacity (x $10^3$ lb/hr) | AGE OF BOILER | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 |
| 10 | 396 | 494 | 594 | 692 | 792 | 890 | 990 | 1090 | 1188 | 1288 | 1388 |
| 20 | 754 | 920 | 1130 | 1320 | 1420 | 1700 | 1980 | 2014 | 2320 | 2460 | 2640 |
| 30 | 1086 | 1360 | 1630 | 1900 | 2360 | 2480 | 2720 | 3000 | 3320 | 3540 | 3800 |
| 40 | 1430 | 1790 | 2280 | 2500 | 2860 | 3220 | 3560 | 3940 | 4280 | 4640 | 5000 |
| 50 | 1658 | 2014 | 2480 | 2900 | 3320 | 3720 | 4140 | 4560 | 4980 | 5380 | 5800 |
| 60 | 1910 | 2400 | 2870 | 3340 | 3820 | 4300 | 4800 | 5340 | 5740 | 6240 | 6700 |
| 70 | 2300 | 2820 | 3400 | 3960 | 4540 | 5100 | 5680 | 6240 | 6800 | 7360 | 7920 |
| 80 | 2440 | 3120 | 3680 | 4280 | 4880 | 5520 | 6020 | 6740 | 7340 | 7960 | 8560 |
| 90 | 2930 | 3650 | 4480 | 5130 | 5870 | 6600 | 7350 | 8100 | 8840 | 9560 | 10300 |
| 100 | 3200 | 4000 | 4800 | 5600 | 6400 | 7200 | 8000 | 8800 | 9600 | 10800 | [illegible] |
| 110 | 3460 | 4320 | 5100 | 6050 | 6900 | 7780 | 8650 | 9500 | 10300 | 11400 | 12000 |
| 120 | 3610 | 4500 | 5410 | 6250 | 7200 | 8100 | 9000 | 9900 | 10800 | 11700 | 12600 |
| 130 | 5510 | 6700 | 8300 | 9700 | 11000 | 12500 | 13800 | 15200 | 16600 | 18000 | 19300 |
| 140 | 6050 | 7550 | 9100 | 10500 | 12100 | 13600 | 15200 | 16500 | 18100 | 19600 | 21000 |
| 150 | 6240 | 8200 | 9370 | 10900 | 12500 | 14000 | 15500 | 17200 | 18700 | 20300 | 21800 |
| 160 | 6950 | 8650 | 10400 | 12100 | 13900 | 15500 | 17300 | 19000 | 20800 | 22500 | 24300 |
| 170 | 7100 | 8850 | 10500 | 12200 | 14200 | 16000 | 17800 | 19400 | 21200 | 23000 | 24800 |
| 180 | 7200 | 8940 | 10650 | 12300 | 14350 | 16200 | 18600 | 19800 | 21500 | 23400 | 25200 |
| 190 | 7300 | 9100 | 10800 | 12400 | 14400 | 16400 | 18100 | 20000 | 21800 | 23600 | 25400 |
| 200 | 7350 | 9180 | 11000 | 12800 | 14600 | 16500 | 18300 | 20400 | 22000 | 23800 | 25700 |

## TABLE 4-19
## Coal Fired Annual Boiler Maintenance Cost

| Rated Boiler Capacity ($10^3$ lb/hr)[1] | Age of Boiler (years) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 |
| 10 | 542 | 675 | 812 | 950 | 1,080 | 1,220 | 1,360 | 1,490 | 1,620 | 1,760 | 1,900 |
| 20 | 1,060 | 1,290 | 1,580 | 1,850 | 1,990 | 2,380 | 2,770 | 2,830 | 3,250 | 3,450 | 3,700 |
| 30 | 1,540 | 1,940 | 2,310 | 2,700 | 3,360 | 3,510 | 3,860 | 4,260 | 4,710 | 5,050 | 5,390 |
| 40 | 2,050 | 2,550 | 3,260 | 3,560 | 4,090 | 4,610 | 5,100 | 5,620 | 6,100 | 6,620 | 7,140 |
| 50 | 2,300 | 2,990 | 3,670 | 4,300 | 4,910 | 5,500 | 6,120 | 6,750 | 7,360 | 7,930 | 8,580 |
| 60 | 2,940 | 3,700 | 4,430 | 5,130 | 5,900 | 6,620 | 7,400 | 8,220 | 8,830 | 9,610 | 10,200 |
| 70 | 3,690 | 4,530 | 5,440 | 6,340 | 7,270 | 8,180 | 9,090 | 10,000 | 10,900 | 11,800 | 12,700 |
| 80 | 4,020 | 5,120 | 6,080 | 7,050 | 8,000 | 9,100 | 9,990 | 11,100 | 12,100 | 13,100 | 14,100 |
| 90 | 4,890 | 6,300 | 7,740 | 8,870 | 10,100 | 11,400 | 12,700 | 14,000 | 15,300 | 16,500 | 17,800 |
| 100 | 5,800 | 7,220 | 8,690 | 10,100 | 11,600 | 13,000 | 14,400 | 15,900 | 17,400 | 19,600 | 20,300 |
| 110 | 6,380 | 7,940 | 9,390 | 11,100 | 12,700 | 14,300 | 15,900 | 17,500 | 19,000 | 21,000 | 22,100 |
| 120 | 6,720 | 8,390 | 10,100 | 11,600 | 13,400 | 15,100 | 16,800 | 18,400 | 20,100 | 21,800 | 23,500 |
| 130 | 10,600 | 13,000 | 16,000 | 18,800 | 21,200 | 24,100 | 26,600 | 29,300 | 32,000 | 34,700 | 37,200 |
| 140 | 12,100 | 15,100 | 18,200 | 21,000 | 24,200 | 27,200 | 30,400 | 33,000 | 36,200 | 39,200 | 42,000 |
| 150 | 12,800 | 16,800 | 19,100 | 22,200 | 25,600 | 28,600 | 31,600 | 35,100 | 38,200 | 41,500 | 44,500 |
| 160 | 14,600 | 18,100 | 21,800 | 25,300 | 29,100 | 32,500 | 36,200 | 39,800 | 43,500 | 47,000 | 50,900 |
| 170 | 15,200 | 19,000 | 22,600 | 26,300 | 30,500 | 34,400 | 38,300 | 41,700 | 45,600 | 49,500 | 53,200 |
| 180 | 15,800 | 19,700 | 23,500 | 27,000 | 31,600 | 35,600 | 39,600 | 43,600 | 47,400 | 51,400 | 55,300 |
| 190 | 16,400 | 20,500 | 24,300 | 27,900 | 32,400 | 37,000 | 40,700 | 45,000 | 49,000 | 53,100 | 57,000 |
| 200 | 16,900 | 21,100 | 25,300 | 29,500 | 33,600 | 38,000 | 42,100 | 47,000 | 50,700 | 54,800 | 59,100 |

[1] If boiler is rated in Btu/hr, use $10^6$ Btu/hr = $10^3$ lb/hr.

## TABLE 4-20
## Annual Maintenance Cost for Steam Distribution Systems

| Average Age Years | Prefabricated Insulated Pipe System: Direct Burial $/in. ft of supply main, With Cond Ret | Direct Burial, W/out Cond Ret | Pipe Tunnel, Trench or Overhead $/in.ft of supply main, With Cond Ret | Pipe Tunnel, Trench or Overhead, W/Out Cond Ret |
|---|---|---|---|---|
| 1 | 0.046 | 0.021 | 0.021 | 0.009 |
| 5 | 0.076 | 0.034 | 0.037 | 0.017 |
| 10 | 0.108 | 0.049 | 0.053 | 0.024 |
| 15 | 0.140 | 0.062 | 0.068 | 0.031 |
| 20 | 0.168 | 0.076 | 0.083 | 0.037 |
| 25 | 0.184 | 0.090 | 0.098 | 0.045 |
| 30 | 0.230 | 0.100 | 0.110 | 0.050 |
| 35 | 0.261 | 0.115 | 0.126 | 0.058 |
| 40 | 0.291 | 0.130 | 0.140 | 0.064 |
| 45 | 0.324 | 0.143 | 0.156 | 0.073 |
| 50 | 0.351 | 0.156 | 0.172 | 0.078 |

| Average Age | Insulated Pipe With Weatherproof Jacket | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Burial-Concrete Encased | | | | Pipe Tunnel, Trench, or Overhead | | | |
| | Cellular Glass $/in.ft of supply main | | Fiber Glass $/in.ft of supply main | | Cellular Glass $/in.ft of supply main | | Fiber Glass $/in.ft of supply main | |
| Years | With Cond Ret | W/Out Cond Ret | With Cond Ret | W/Out Cond Ret | With Cond Ret | W/Out Cond Ret | With Cond Ret | W/Out Cond Ret |
| 1 | 0.025 | 0.012 | 0.022 | 0.012 | 0.010 | 0.005 | 0.009 | 0.004 |
| 5 | 0.042 | 0.021 | 0.038 | 0.019 | 0.018 | 0.009 | 0.016 | 0.008 |
| 10 | 0.059 | 0.030 | 0.053 | 0.028 | 0.026 | 0.012 | 0.023 | 0.011 |
| 15 | 0.076 | 0.039 | 0.069 | 0.035 | 0.035 | 0.015 | 0.030 | 0.014 |
| 20 | 0.091 | 0.046 | 0.083 | 0.043 | 0.041 | 0.019 | 0.036 | 0.018 |
| 25 | 0.105 | 0.055 | 0.099 | 0.051 | 0.049 | 0.021 | 0.044 | 0.021 |
| 30 | 0.125 | 0.063 | 0.112 | 0.038 | 0.055 | 0.025 | 0.049 | 0.024 |
| 35 | 0.141 | 0.071 | 0.128 | 0.066 | 0.063 | 0.028 | 0.057 | 0.028 |
| 40 | 0.158 | 0.080 | 0.143 | 0.074 | 0.070 | 0.032 | 0.062 | 0.031 |
| 45 | 0.175 | 0.089 | 0.159 | 0.082 | 0.077 | 0.035 | 0.070 | 0.034 |
| 50 | 0.189 | 0.097 | 0.174 | 0.089 | 0.085 | 0.039 | 0.076 | 0.038 |

Notes: 1. For calcium silicate insulation, use data for Fiber Glass.

2. Maintenance cost for condensate return systems are based on inch-feet of steam supply main; inch-feet of condensate return is not required.

TABLE 4-21
Annual Maintenance Cost for Gas Piping Systems

| Average Age Years (1) | Annual Maintenance Cost $/mile (2) | Average Age Years (3) | Annual Maintenance Cost $/mile (4) |
|---|---|---|---|
| 1 | 20 | 30 | 135 |
| 5 | 20 | 35 | 165 |
| 6 | 20 | 40 | 180 |
| 10 | 40 | 45 | 220 |
| 15 | 65 | 50 | 245 |
| 20 | 85 | 55 | 275 |
| 25 | 110 | 60 | 300 |

TABLE 4-22
Hospital Equipment Sterilizers

| STERILIZER | | |
|---|---|---|
| | HEAT CONSUMPTION 10/BTU/HR | |
| SIZE INCHES | FABRIC LOADS | SOLUTION LOADS |
| 24 x 24 x 36 | 55 | 60 |
| 24 x 24 x 48 | 65 | 70 |
| 24 x 24 x 60 | 70 | 80 |
| 24 x 36 x 48 | 80 | 90 |
| 24 x 36 x 60 | 85 | 100 |
| 30 x 42 x 84 | 125 | 155 |
| 36 x 42 x 84 | 145 | 185 |
| 42 x 48 x 96 | 210 | 265 |
| 48 x 54 x 96 | 260 | 340 |
| 48 x 60 x 96 | 285 | 375 |
| 60 x 66 x 96 | 395 | 515 |
| 60 x 66 x 156 | 700 | 900 |
| 60 x 66 x 228 | 1,000 | 1,200 |

| STERILIZERS: | |
|---|---|
| TYPE | CONSUMPTION $10^3$ Btu/hr |
| BEDPAN | $2.9 \times 10^3$ Btu/hr |
| DRESSING (per 10 in. Length) | 7.1 " |
| INSTRUMENT (per 100 cu in.) | 2.9 " |
| WATER (per 10 gal water) | 5.8 " |
| <u>STILLS</u> - per 100 gal distilled water | $102.6 \times 10^3$ Btu |
| DISINFECTING OVENS | |
| Up to 50 cu ft (per 10 cu ft) | $29.8 \times 10^3$ Btu/hr |
| 50 to 100 cu ft (per 10 cu ft) | 23.8 " |
| Over 100 cu ft (per 10 cu ft) | 14.9 " |

TABLE 4-23
Galley Equipment

| | |
|---|---|
| DISHWASHERS (Two bin) | 58.6 x $10^3$ Btu/hr |
| PLATE & DISH WARMERS | |
| Per 100 sq ft shelf | 58.6 " |
| Per 20 cu ft shelf | 29.3 " |
| STEAM TABLE (per ft length) | 36.6 " |
| (Per 20 sq ft tank) | 29.3 " |
| BAIN MARIE (per ft length, 30 in wide) | 18.0 " |
| (Per 10 sq ft tank) | 29.3 " |
| STEAM JACKETED KETTLE | |
| 10 gal capacity | 13.0 " |
| 25 | 29.3 " |
| 40 | 44.0 " |
| 60 | 58.6 " |
| DIRECT VEGETABLE STEAMER (Per Compartment) | 29.3 " |
| POTATO STEAMER | 29.3 " |

TABLE 4-24
Heat Loss Due to Ventilation Fan Operation

Btu loss/hr = cu ft/hr exhausted x 0.075 x 0.24 x average temperature difference during period of fan operation:

$$H = 0.24d(t_i - t_o)NV, \qquad (4\text{-}3)$$

where

$H$ = heat required, Btu/hr,
$d$ = air density (normally 0.075 lb/ft$^3$),
$t_i$ = inside design temperature,
$t_o$ = outside design temperature,
$N$ = no. of air changes/hr, and
$V$ = volume (cu ft).

Assuming normal air density, you can simplify the formula to:

$$H = \frac{(t_i - t_o)NV}{55}$$

$$= \frac{t_i - t_o}{55} \times ft^3/hr$$

TABLE 4-25
Laundry Equipment

| DRY CLEANING STILL | | | |
|---|---|---|---|
| SIZE Gal | STEAM $10^3$ Btu/hr | SIZE Gal | STEAM $10^3$ Btu/hr |
| 25 | 50 | 125-150 | 170 |
| 50 | 67 | 175-200 | 200 |
| 75 | 100 | 250 | 300 |
| 100 | 135 | 350-400 | 470 |

| DOUBLE-DRUM DRYER | |
|---|---|
| DRUM SIZE Inches | STEAM $10^3$ Btu/hr |
| 24 x 60 | 1,000 |
| 28 x 72 | 1,500 |
| 36 x 84 | 2,350 |
| 36 x 100 | 3,350 |
| 36 x 120 | 4,200 |

SELF-SERVICE LAUNDRIES
WASHERS - 31,000 Btu/cycle for Hot Water

| FLATWORK IRONER | | |
|---|---|---|
| | LENGTH OF ROLL | |
| IRONER SIZE | 100 Inches $10^3$ Btu/hr | 120 Inches of Operation |
| 2 - roll | 104 | 128 |
| 4 - | 210 | 254 |
| 6 - | 310 | 332 |
| 8 - | 429 | 476 |
| 12 - | - | 650 |

| TUMBLER DRYER | |
|---|---|
| TUMBLER SIZE Inches | HEAT INPUT $10^3$ Btu/hr |
| 36 x 24 | 124 |
| 36 x 30 | 131 |
| 36 x 42 | 151 |
| 36 x 48 | 200 |
| 42 x 40 | 218 |
| 42 x 60 | 268 |
| 42 x 90 | 402 |
| 42 x 120 | 536 |

| COMMERCIAL WASHER (ROUGHLY 3 gal HOT WATER/lb CLOTHES WASHED) | | | |
|---|---|---|---|
| WHEEL SIZE DIA X LGTH (in.) | HEAT INPUT $10^3$ Btu/LOAD | WHEEL SIZE DIA X LGTH (in.) | HEAT INPUT $10^3$ Btu/LOAD |
| 30 x 30 | 175 | 42 x 108 | 1,410 |
| 30 x 36 | 227 | 44 x 36 | 520 |
| 30 x 48 | 330 | 44 x 54 | 785 |
| 36 x 36 | 350 | 44 x 60 | 860 |
| 36 x 48 | 470 | 44 x 72 | 1,040 |
| 36 x 54 | 520 | 44 x 84 | 1,210 |
| 36 x 64 | 610 | 44 x 96 | 1,380 |
| 42 x 36 | 470 | 44 x 108 | 1,570 |
| 42 x 54 | 705 | 44 x 120 | 1,730 |
| 42 x 64 | 830 | 54 x 84 | 1,520 |
| 42 x 72 | 940 | 54 x 96 | 1,730 |
| 42 x 84 | 1,100 | 54 x 108 | 1,940 |
| 42 x 96 | 1,260 | 54 x 120 | 2,150 |

## TABLE 4-26
## Sample Steam-Heat-Fuel Quantity Target Summary

Activity NAVSTA  Period 1st Quarter, FY19 69  By ______

Date ______

1. Building Heating (Ref Tables 4-5 and 4-10 and Example Item 2)

| °F Basis | Allowance Btu/DD | Degree Days in Period | TARGET - $10^6$ Btu | |
|---|---|---|---|---|
| 65 | 3,951,000 | 289 | 1142 | |
| 55 | 1,347,000 | 6 | 8 | |
| | | Building Target | | 1150 |

2. Domestic Heating (Ref Example Item 3)

| Equivalent Residents | | Allowance/30 Day | No. of 30 Day Periods | | |
|---|---|---|---|---|---|
| Full Time | 570 | $1.0 \times 10^6$ Btu | 3 | 1710 | |
| Part Time | 54 | $1.0 \times 10^6$ Btu | 3 | 162 | |
| Hospital | 8 | $2.5 \times 10^6$ Btu | 3 | 60 | |
| | | | Domestic Target | | 1932 |

3. Distribution Loss (Ref Example Item 4)

   568,000 Btu/hr × 2184 hrs — 1245

4. Galley Allowance (Ref Example Item 5) — 680
5. Reimbursables (Ref Example Item 6) — 1790
6. Industrial (Ref Example Item 7) — 200
7. Interutility Transfer (Ref Example Item 8) — 0
8. Total Heat System Produced and Purchased Quantity Target (Total of Items 1 thru 7) Enter in Line 7, UCAR — 6997
9. Total Net Production and Purchase (From Line 6, UCAR) — 7774
10. Variance

$$\% \text{ over target} = \frac{\text{Item 9} - \text{Item 8}}{\text{Item 8}} \times 100 = \frac{7774 - 6997}{6997} \times 100 = 11.1\%$$

$$\% \text{ under target} = \frac{\text{Item 8} - \text{Item 9}}{\text{Item 8}} \times 100 = \frac{\quad}{\quad} \times 100 = \quad \%$$

TABLE 4-27 (3 of 8)
Sample Calculations Steam/Heating Allowance

4 Distribution Losses (Pipe)

| 1 Pipe Size Nominal In. | 2 Length ft | 3 Insulation A-above Grnd B-below Grnd | 4 Heat Loss Factor Table 4-10 | 5 Temp. Diff. °F | 6 Temp. Corr Factor 5 x $\frac{1.2}{500}$ + 0.2[1] | 7 Air Velocity Factor Figure 4-2 | 8 Heat Loss Btu/hr 2 x 4 x 6 x 7 |
|---|---|---|---|---|---|---|---|
| 8 | 1,800 | B 2 in. | 160 | 300 | 1.0 | 1.0 | 288,000 |
| 6 | 800 | B 2 in. | 129 | 300 | 1.0 | 1.0 | 103,000 |
| 4 | 900 | B Standard | 141 | 300 | 1.0 | 1.0 | 127,000 |
| 2 | 300 | B Standard | 92 | 300 | 1.0 | 1.0 | 28,000 |
| 1 1/2 | 250 | B Standard | 87 | 300 | 1.0 | 1.0 | 22,000 |
| | | | | | | Total | 568,000 |

Total Heat Loss Target = 2,184 hrs x 568,000 = 1,245 x $10^6$ Btu

Note: Steam Temp = 345°F, trench temp = 45°F; Diff = 300°F
Heat Losses may also be calculated from Table 4-11, NAVFAC MO-303 (Piping Heat Loss Allowance)

[1] See Figure 4-2 (A)

5. Galley Allowance (From papagraph 4-4)

   a. Mess Hall capacity - 500 persons; (average use 460)
   b. Steam requirement per meal .0054 x $10^6$ Btu
   c. Number of meals served in target period, 91 x 3 x 460 = 126,000
   d. Total requirements per quarter; .0054 x $10^6$ x 126,000 = 680 x $10^6$ Btu

6. Reimbursables (Metered)

| | | $10^6$ Btu |
|---|---|---|
| a. Officers Open Mess | | 15 |
| b. Navy Exchange | | 150 |
| c. Ships | | 1000 |
| d. Housing | | - |
| e. Commissary | | 25 |
| f. Air Force Detachment | | 600 |
| | Total | 1790 |

7. Industrial Use (Metered)

| | $10^6$ Btu |
|---|---|
| a. Ships on a non-reimbursable basis | 0 |
| b. Laundry | 0 |
| c. Car Washing | 15 |
| d. Ship's Garbage Cooking | 0 |
| e. Shops | 185 |
| f. Other | 0 |
| g. Sub-total, Industrial Use | 200 |

8. Interutility Transfer

   a. Electric System(1)
   b. Potable Water System
   c. Air Conditioning
   d. Other
   e. Sub-total, Interutility Transfer — 0

Note 1 - The following is a sample calculation for determining steam target requirement of a turbo-generator unit.

Turbo-Generator Unit

Type - straight condensing
Rating - 5,000 kw/hr, 370 psig, 750°F, 2" Hg. abs backpressure
Average loading for targeted period - say 60% or 3,000 kw/hr
Steam rate; 10.1 lb/kw/hr
Heat value main steam (at 370 psi, 750°F): H = 1,390 Btu/lb
Heat value condensate (at 2" hg). h= 69 Btu/lb
Turbine heat rate = steam rate (H-h) = 10.1 (1390 - 69) = 13,340 Btu/kw/hr
Turbine steam target = average loading x heat rate x operating hours
= 3,000 x 13,340 x 2,184 = 87,000 x $10^6$ Btu

B. Boiler Efficiency and Distribution Subdivision Factor

1. Steam Requirement for Production (Refer to Tables 4-13, 4-14, 4-15)

a. Operating Conditions
1) Boiler; 120 psig, 350°F; H = 1,192.3 Btu/lb
2) Dearator; 5 psig, 327°F; h = 195
3) Condensate return; 160°F,h = 118
4) Make-up; 25% at 60°F, h = 28
5) Average return temperature (Table 4-14)

$$= \frac{\text{\% weight condensed (temp. cond.)} + \text{\% weight make-up (temp. make-up)}}{100}$$

$$= \frac{75 \times 160 + 25 \times 60}{100} = 135°\text{F};\ h = 102\ \text{Btu/lb}$$

b. Percent of Steam Required for Production
1) % for Feedwater Heating

$$= \frac{\text{Heat Content Feedwater - Heat Content of Return Line}}{\text{Heat Content Steam - Heat Content of Return Line}}$$

$$= \frac{195 - 102}{1{,}192.3 - 102} = 8.5\%$$

| | |
|---|---|
| 2) % for intermittent blowdown | 0.5% |
| 3) % for soot blowing | 1.0% |
| 4) % for steam atomization | 1.5% |
| 5) % for banking and start-up | 0% |
| 6) % for No. 6 Fuel Oil Heating | 0.5% |
| 7) % Radiation and Unaccounted losses | 1.0% |
| 8) Total Percent | 13.0% |

c. Amount of steam used in Production (Refer to Table 4-15)

= Gross Plant Production (Line 1, UCAR) x % required for production

1st quarter = 8,935 x $10^6$ Btu x 13% = 1,161 x $10^6$ Btu(1)

2nd quarter = $10^6$ Btu x % = $10^6$ Btu(1)

3rd quarter = $10^6$ Btu x % = $10^6$ Btu(1)

4th quarter = $10^6$ Btu x % = $10^6$ Btu(1)

Note: Insert calculated amount of steam used in Production in Line 2, UCAR

TABLE 4-27 (6 of 8)
Sample Calculations Steam/Heating Allowance

2. Actual Average Boiler Plant Efficiency (Refer to Table 4-16)

a. Average efficiency $= \frac{\text{Heat Output}}{\text{Heat Input}} \times 100$

$= \frac{\text{Line 1, UCAR}}{\text{Line 15, UCAR}} \times 100$

1st Quarter $= \frac{8{,}935 \times 10^6 \text{ Btu}}{11{,}912 \times 10^6 \text{ Btu}} \times 100 = 75\%$

3. Target Boiler Efficiency

Use boiler design efficiency corrected for plant age, and changes in operating conditions, etc.

Target Efficiency = 80% (Design) - 2 (correction) = 78%

Ratio of actual to target efficiency $= \frac{75 \text{ (from Par. 2)}}{78 \text{ (from Par. 3)}} = 0.962$

4. Distribution Maintenance Subdivision Factors

| Actual Distribution Maintenance Cost Description | Line of UCAR | Prior Fiscal Year 1st Qtr. July-Sept. | 2nd Qtr. Oct.-Dec. | 3rd Qtr. Jan.-March | 4th Qtr. April-June | Total |
|---|---|---|---|---|---|---|
| Labor | 39 | $5,150 | $ 825 | $1,750 | $1,650 | |
| Material | 40 | 450 | 175 | 450 | 650 | |
| Contractural and Other | 41 | 0 | | | | |
| Total | | $5,600 | $1,000 | $2,200 | $2,300 | $11,100 |
| Quarterly Subdivision (1) | | 0.505 | 0.090 | 0.198 | 0.207 | 1.000 |

Note: (1) Quarterly Subdivision $= \frac{\text{Each Quarterly Total}}{\text{Yearly Total}}$

5. Yearly Distribution Maintenance Target Cost

| | |
|---|---|
| a. Inch-Feet distribution - (see A-4) | 23,775 |
| b. Unit Cost of maintenance (Table 4-20) (based on 20 year age) | $ 0.168 |
| c. Yearly target Maintenance Cost (a x b) | $ 3,990 |

TABLE 4-27 (7 of 8)
Sample Calculations Steam/Heating Allowance

STEAM, HEAT AND FUEL UNIT COST TARGET SUMMARY

| | | | UCAR line number |
|---|---|---|---|
| 1. Quantities from Current UCAR - 1st Quarter of FY | | | |
| a. Net Plant Production | $10^6$Btu | 7,774 | 3 |
| b. Purchased | $10^6$Btu | 0 | 4 + 5 |
| c. Total Production and Purchase (UCAR 3, 4 and 5) | $10^6$Btu | 7,774 | 6 |
| d. Production Quantity Target | $10^6$Btu | 6,997 | 7 |
| e. Interutility Transfers From | $10^6$Btu | 0 | 8 |
| f. Net Production and Purchase (UCAR 6-8) | $10^6$Btu | 7,774 | 9 |
| g. Quantities Loss in Distribution (sample calc., A-04) | $10^6$Btu | 1,245 | 10 |
| h. Net Quantity Delivered (UCAR 9-10) | $10^6$Btu | 6,529 | 11 |
| 2. Produced Unit Cost Target | | | |
| a. Fuel Cost | | \$ 4,750 | 18 |
| b. Total Cost (sum of UCAR Lines 17 thru 25) | | 11,790 | |
| c. Interutility Transfers to | | | |
| 1) Steam | | 0 | 26 |
| 2) Electricity | | 460 | 27 |
| 3) Potable Water | | 140 | 28 |
| d. Gross Production Cost | | 12,390 | 31 |
| e. Fuel and Production Interutility Transfers From | | | |
| 1) Actual items a + c; (Sum of UCAR Lines 8 + 26 thru 29) | | 5,350 | |
| 2) Target (item e(1) x ratio of actual to target efficiency, 0.962)[1] | | 5,147 | |
| f. Targeted Production Cost (items [b + e(2)] -a) | | 12,187 | |
| g. Unit Cost Target Produced (item f ÷ 1a) - \$/$10^6$ Btu | | 1.56 | 49 |
| h. Unit Cost of Utilities Produced (UCAR Lines 31 ÷ 3) \$/$10^6$ Btu | | 1.59 | 48 |
| i. Ratio of Actual to Target Cost (UCAR Lines 48 ÷ 49) | | 1.02 | |
| j. Variance of Actual from Target Cost; 100 x (item i - 1)% | | 2.00 | |
| 3. Delivered Unit Cost Target | | | |
| a. Net Quantities Delivered (UCAR Lines 9-10) | $10^6$Btu | \$6,529 | 11 |
| b. Quarterly Maintenance Subdivision Factor (sample Calculation B, 4) | | 0.505 | |
| c. Yearly Target Maintenance Cost (sample Calculation B, 5c) | | \$3,990 | |

[1]Sample calculation B, 3.

TABLE 4-27 (8 of 8)
Sample Calculations Steam/Heating Allowance

| | | |
|---|---|---|
| d. Quarterly Target Maintenance Cost (item 3b x item 3c) | $ 2,015 | |
| e. Total Cost of Production and Purchase | $12,390 | 35 |
| f. Targeted Production Cost (item 2f) | $12,187 | |
| g. Distribution Operating Cost (sum of UCAR Lines 36, 37, 38) | 0 | 36,37,38 |
| h. Distribution Maintenance Cost (sum of UCAR Lines 39, 40, 41) | $ 2,450 | 39,40,41 |
| i. Distribution Overhead Cost (sum of UCAR Lines 42, 43) | $ 250 | 42,43 |
| j. Total Cost of Distribution (sum of UCAR Lines 36 thru 43) | $ 2,700 | 44 |
| k. Total Delivered Cost (sum of UCAR Lines 35 + 44) | $15,090 | 45 |
| l. Targeted Delivered Cost (sum of items d,f,g,i) | $14,452 | |
| m. Unit Cost Delivered (UCAR Lines 45 ÷ 11) | 2.31 | 46 |
| n. Targeted Unit Cost Delivered (item 1 ÷ UCAR Line 11) | 2.21 | 47 |
| o. Ratio of Actual to Traget Unit Cost (UCAR Lines 46 ÷ 47) | 1.045 | |
| p. Variance of Actual from Target Unit Cost 100 x (item 3o - 1)% | 4.5 | |

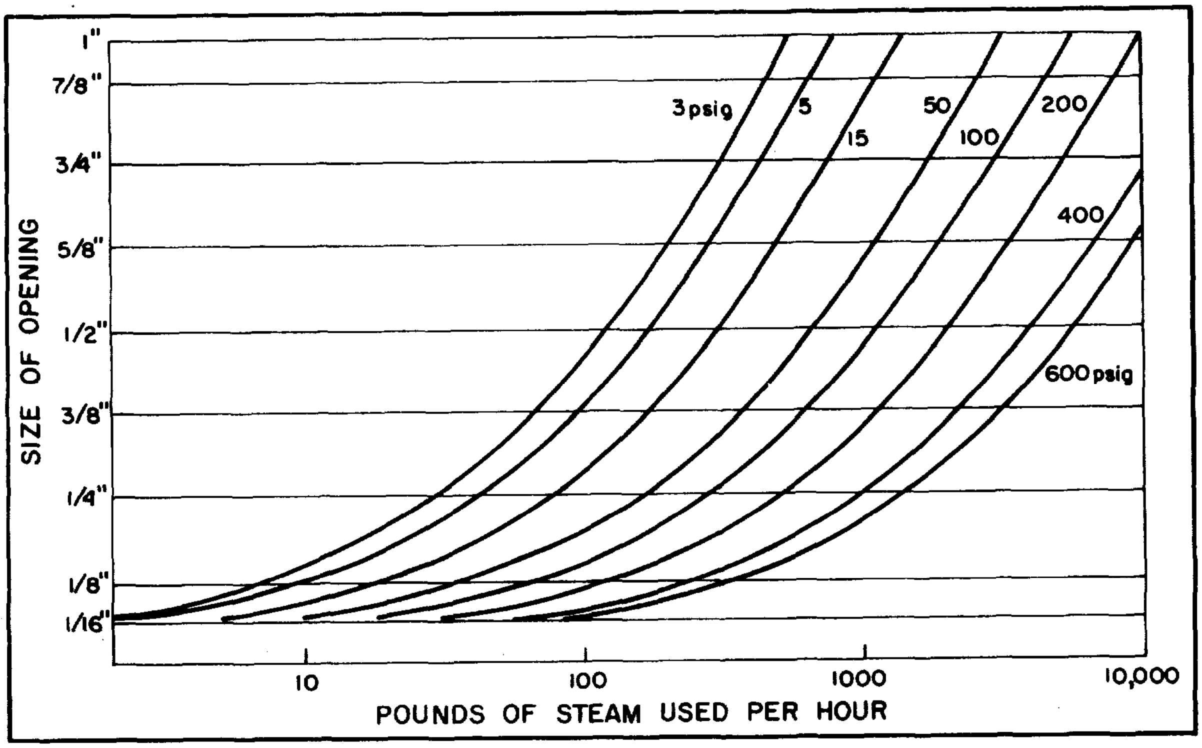



FIGURE 4-4
Steam Cleaning

## CHAPTER 5. TARGETS FOR AIR CONDITIONING

5.1 GENERAL. The procedures outlined in this section will provide a method for determining target air conditioning requirements, in terms of full-load ton-hours, and for determining the electrical or steam energy needed to fulfill these requirements. The electric and steam energy quantities estimated using these procedures can be added directly to the steam or electric targets. The period for air conditioning targets should be chosen so as to be consistent with the electric or steam targets to which they contribute. The methods outlined below for determining equivalent full-load ton-hours are considered adequate for the general class of buildings such as office buildings, barracks, dwellings, shops, mess facilities, and classrooms. Special applications, such as large process loads, communications and data processing equipment, etc., should be treated individually, giving consideration to each user's constraints.

The equations in this section were developed to provide a relatively simple, general method for estimating air conditioning requirements for target use. Most of the constants are average values which vary from case to case. The engineer should investigate the applicability, in each individual case, of such factors as average load estimation, HP/ton estimation, motor efficiency, steam requirements per ton, etc. Judgement and experience on the part of the team member will, to a great extent, determine the quality of this particular target. The methods described in this section are intended to provide an approximate usage estimate of wide applicability with a minimum of work. Other methods of developing reasonable targets are, of course, available, and this information is offered as an aid to the personnel ultimately responsible for the use, operation and maintenance of air conditioning systems. It is intended to make the management of these increasingly important systems more effective. The following information is required for the estimation of the energy required for air conditioning:

(1) Total heat dissipation of building lighting (see Table 5-2).

(2) Total heat dissipation of building motors, etc. (see Table 5-3).

(3) Total heat dissipation of personnel within the building. This value must be approximate, depending on the purpose and use of the building (see Table 5-4).

(4) Total heat dissipation of steam-heated appliances (see Table 5-5).

(5) Total heat dissipation of electric and gas appliances (see Table 5-6).

(6) The number of cooling degree-hours in the target period.

(7) Total heat dissipation of special equipment such as automatic controls or computer equipment. This information may be obtained from the equipment manufacturers.

(8) Total installed tonnage of air conditioning, and type of refrigeration used. If any of the machinery employs the "economy cycle," which utilizes a varying amount of cool outside air to lighten the refrigeration load, or if the installation is of the evaporative type, these factors

should be taken into consideration.

(9) Much of this information should be available at the electric utility serving the area.

5.2 AIR CONDITIONING REQUIREMENTS ESTIMATION. A preliminary quick estimate of air conditioning requirements can be obtained using Tables 5-7 and 5-8. The average square footage per ton estimates shown in Table 5-7 represent the worst case for each type of building: the Gulf Coast and Florida. To obtain an estimate for other geographic locations in the United States these values should be multiplied by the appropriate decimal in Table 5-8. This method is approximate, but when applied with a reasonable cooling season factor and cooling factor and cooling degree hours above 65 degrees F., wet bulb, should give a quick target estimate for cooling season energy requirements for most comfort systems. Other methods must be applied to systems with large process loads and for systems with large internal loading factors.

To obtain more substantial air conditioning target information the refrigeration equipment for each system of fifty tons or more should be metered, whether electrically or steam driven. Metering of electrically driven units may be accomplished with either a kilowatt-hour meter or an elapsed time meter. The hours of operation need only be multiplied by the name-plate tonnage of the unit. In either case, the meter should only be applied to the refrigeration portion of the machine. Readings should be recorded daily and compared against the daily outdoor wet bulb and dry bulb temperatures. In the course of a typical cooling season, degree-hour or degree-day data will be accumulated which may be used in determining full-load ton-hours of air conditioning required. With this information at hand, a useful equation for determining equivalent hours of operation is:

$$H_e = m(b + cf), \tag{5-1}$$

where
- $H_e$ = equivalent full load operating hours of refrigerating equipment during a typical cooling season (May 15 to Oct. 15),
- $m$ = total hours that the air conditioned space is in use,
- $b$ = fraction of maximum load which is internal,
- $c$ = fraction of maximum load which is external, and
- $f$ = ratio of the number of hours when the outside wet bulb temperature is greater than 65 degrees F. to the total number of hours the system is running during the cooling season.

Maximum internal load in tons can be determined by the following equation:

$$L_i = (L_l + L_p + L_e) \frac{1}{12{,}000 \text{ B.t.u./hr./ton}}, \tag{5-2}$$

where $L_l$ = B.t.u./hr. dissipated by lighting,
$L_m$ = B.t.u./hr. dissipated by motors, etc., during hours of actual use,
$L_p$ = B.t.u./hr. dissipated by personnel, and
$L_e$ = B.t.u./hr. dissipated by other equipment in the building.

Maximum external load can be determined by subtracting the internal load from the total installed tonnage.

The equivalent hours of operation determined by equation 5-1, multiplied by the installed tonnage, may then be used to target the input energy required to provide the necessary air conditioning refrigeration.

In exceedingly dry climates, where the wet bulb temperature may not rise above 65°F. even though there is a significant demand for air conditioning, equation 5-1 is likely to become too inaccurate to be useful. If standard air conditioning equipment, as opposed to evaporation cooling devices, is used in such a climate, the EFD must establish whatever target allowance or targeting procedure is necessary for the particular installation. It should be noted that standard design procedures for a dry climate usually call for evaporation cooling devices and that these devices are much less expensive to operate than conventional equipment: Air conditioning probably should not be targeted as a separate utility for installations which use evaporation cooling devices.

5.3 AIR CONDITIONING ELECTRICAL ENERGY USE. The amount of electrical energy used by electrically driven air conditioning in the target period may be estimated by the equation:

$$E = 0.75TH_e\left(\frac{HP/T}{e}\right), \qquad (5\text{-}3)$$

where $E$ = kw.-hr. of electric energy,
0.75 = the no. of watts/horsepower (approx.),
$TH_e$ = equivalent ton-hours of operation,
$HP/T$ = compressor input, horsepower/ton, and
$e$ = motor efficiency.

Approximations for HP/T are:

Centrifugal units - 0.9 HP/ton.
Reciprocating units, under 75 tons - 1.0 HP/ton.
Reciprocating units, 75 tons and over - 0.7 HP/ton.

Approximations for e are:

Driving motors up to 25 tons - 0.85.
Driving motors over 25 tons - 0.90.

The above energy requirements apply to the refrigeration units in the system. To estimate the total energy demand, which includes the air handling equipment, the value for refrigeration requirements is multiplied by 1.4.

5.4 AIR CONDITIONING STEAM ENERGY USE. The following approximations can be used for determining steam requirements for steam-driven air conditioning units when the actual heat rates of the equipment are not known:

| | |
|---|---|
| Back pressure turbine | 12,600 B.t.u./ton/hr. |
| Condensing turbine | 16,000 B.t.u./ton/hr. |
| Absorption | 18,600 B.t.u./ton/hr. |

These allowances are multiplied by the equivalent full-load ton-hours as derived above. The absorption heat rate estimate can also be used for units driven by high temperature water. Direct-fired absorption units must be studied separately, considering their individual heat rates. The electrical requirements for these systems will be estimated separately and added to the electrical quantity target.

5.5 TARGET USE. In most cases the input requirements target developed for air conditioning is applied to the more general Quantity Targets for Steam and Electricity. However, a separate target can be reported on the UCAR for those air conditioning systems which are metered directly, such as central chilled water systems or those systems which have their own heat source or a metered heat input. For those systems with their own independent heat source, a fuel quantity should be developed based on the individual heat rate of the equipment and the procedures in Chapter 4.

A worksheet in the form of Table 5-1 should be developed and completed using equations 5-1, 5-2 and 5-3 and the estimated usage factors found in Tables 5-2 through 5-6. Each activity must modify these constants to compensate for conditions which vary from the norms set forth. If the quick estimate method (Table 5-7) is used, the totals must take into particular account the applicable zone of Table 5-8.

5.6 EXAMPLE OF TARGET CALCULATION, USING EQUATIONS 5-1 THROUGH 5-3. A building of 20,000 square feet total area contains 12,000 square feet of shops (light industrial) and 8,000 square feet of office space, with 102 shop workers and 50 office personnel. It is lighted by flourescent lighting. Air conditioning is supplied by electrically driven centrifugal units, 150 ton capacity. To obtain maximum internal load (see Equation 5-2):

For lighting load, $L_i$, multiply areas by the factors in Table 5-2:

$$L_l = 12{,}000 \text{ ft}^2 \times 20.0 = 8{,}000 \text{ ft}^2 \times 24.0 = 0.432 \times 10^6 \text{ B.t.u./hr.}$$

For machinery heat load, $L_m$, sum up the actual loads, using the data in Table 5-4 supplemented if necessary by a standard air conditioning handbook or manufacturer's data. In this example, we assume that:

$$L_m = 0.115 \times 10^6 \text{ B.t.u./hr.}$$

For personnel heat load, multiply the number of workers in each area by the factors in Table 5-4:

$$L_p = 102 \text{ shopworkers} \times 800 + 50 \text{ office workers} \times 475 = 0.105 \times 10^6 \text{ B.t.u./hr.}$$

For other equipment, $L_e$, sum up the actual appliance loads, using the data in Tables 5-5 and 5-6, supplemented by handbook or manufacturers' data. In this example, we assume that:

$$L_e = 0.540 \times 10^6 \text{ B.t.u./hr.}$$

So, the total maximum internal load, $L_i$, in tons, from equation (5-2) is:

$$L_i = \frac{L_l + L_m + L_p + L_e}{12{,}000} = \frac{1.192 \times 10^6}{12 \times 10^3} = 99 \text{ tons} \qquad (5\text{-}2)$$

To obtain maximum external load, subtract internal load from installed tonnage:

$$L_E = 150 - 99 = 51 \text{ tons}$$

To obtain equivalent full load operation hours (see equation 5-1):

Total hours, m, that the space is in use for one month, using a 9-hour day, 5-day week, 1 shift,

$$m = 198 \text{ hours}$$

Fraction of load that is internal, b:

$$b = \frac{99T}{150T} = 0.66$$

Fraction of load that is external, c:

$$c = \frac{51T}{150T} = 0.34$$

Number of hours outdoor wet-bulb temperature exceeded 65°F. during month is obtained from weather bureau or, better, from records at the activity. In this example, it was found to be 472 hours. Since there are 744 total hours in a 31 day month, the ratio, f, is:

$$f = \frac{472 \text{ hr.}}{744 \text{ hr.}} = 0.63$$

Equivalent full load operation hours, $H_e$, are obtained by:

$$H_e = m(b + cf) = 198(0.66 + 0.34 \times 0.63) = 172 \text{ hours.} \qquad (5\text{-}1)$$

The equivalent electric energy, E, consumption (equation 5-3) is obtained as follows.

Total tonnage is 150, and equivalent full load operation hours are 172, as calculated in the foregoing paragraphs. Horsepower of the air conditioning unit is 0.9 HP/ton and efficiency e = 0.90, per paragraph 5.3 for centrifugal units over 25 tons (or use manufacturer's data).

$$E = 0.75\ TH_e \frac{HP/T}{e} = 0.75 \times 150 \times 172 \times \frac{0.9}{0.9} = 19{,}350 \text{ kw.-hr.} \qquad (5\text{-}3)$$

This is refrigeration load only. To obtain total load (including fans, blowers, etc.) multiply operating hours by rated load and add to the above, or use the factor 1.4:

$$(19{,}350)\ (1.4) = 27{,}090 \text{ kw.-hr.}$$

TABLE 5-1
Sample Activity Air Conditioning Requirements

| Station: | Period: | Prepared by: | | |
|---|---|---|---|---|
| Refrigeration | | | | |
| 1. Metered Air Conditioning | | | | |
| a. Steam-driven | | | lbs | Equiv T-H |
| b. Electric | | | kw-hr | Equiv T-H |
| 2. Targeted Usage (paragraph 5-2) | | | | |
| a. Residences (barracks housing, BOQ) | | | | T-H |
| b. Offices, schools, auditoriums, etc. | | | | T-H |
| c. Mess halls | | | | T-H |
| d. Hospitals | | | | |
| Patient rooms | | | | |
| Public areas | | | | |
| e. Shops, Hangars, etc. | | | | |
| Light assembly and repair | | | | |
| Heavy construction and repair | | | | |
| f. Other uses, outside of any of the above (Includes cooling of EDP equipment, etc.) | | | | |
| 3. Total electric powered refrigeration (1.b through 2.f) | | | | T-H |
| 4. Electric consumption (ton-hours × a conversion factor [1]) | | | | kw-hr |
| Air handling (item 4 × 0.4, or rated total air handling load × operating hours) | | | | kw-hr |
| 5. Total electric consumption | | | | kw-hr |
| 6. Steam consumption (ton-hours × heat rate) | | | | Btu |
| The total electric consumption and total steam consumption are to be added to the appropriate quantity targets. | | | | |

[1] The conversion factor is to be established by the EFD or calculated from paragraph 5-3.

## TABLE 5-2
## Approximate Heat Given Off by Lights

| Application | Level of Illumination Foot-candles | Class[1] | FLUORESCENT Low | FLUORESCENT Avg. | FLUORESCENT High | Class[1] | INCANDESCENT Low | INCANDESCENT Avg. | INCANDESCENT High |
|---|---|---|---|---|---|---|---|---|---|
| | | | Btu per (sq ft) (hr) | | | | Btu per (sq ft) (hr) | | |
| Armories | 30 | A | 5.25 | 6.0 | 9.0 | A | 12.0 | 14.0 | 19.0 |
| Banks | 30 | A | 5.0 | 7.0 | 10.0 | A | 10.0 | 15.0 | 20.0 |
| Barber Shops and Beauty Parlors | 50 | B | 12.0 | 16.5 | 24.5 | B | 20.0 | 24.0 | 30.0 |
| Court Rooms | 20 | B | 4.8 | 6.6 | 9.8 | B | 10.0 | 14.0 | 22.0 |
| Dance Halls | 5 | C | 1.7 | 3.7 | 8.0 | B | 3.5 | 7.0 | 12.0 |
| Drafting Rooms— | | | | | | | | | |
| Prolonged Close Work, Art Drafting and Designing in Detail | 50 | B | 10.0 | 15.0 | 20.0 | C | 25.0 | 40.0 | 50.0 |
| Hospitals— | | | | | | | | | |
| General | 50 | A | 8.0 | 12.0 | 18.0 | A | 25.0 | 35.0 | 55.0 |
| Operating Rooms— | | | | | | | | | |
| For Major Operations | 1000 | A | 50.0 | 100.0 | 150.0 | A | 100.0 | 200.0 | 300.0 |
| For Minor Operations | 200 | A | 20.0 | 40.0 | 60.0 | A | 40.0 | 80.0 | 150.0 |
| Hotels— | | | | | | | | | |
| Dining Room | 5 | C | 1.7 | 2.5 | 4.0 | C | 3.5 | 5.0 | 8.0 |
| Kitchen | 20 | A | 4.0 | 6.0 | 8.0 | B | 15.0 | 21.0 | 33.0 |
| Library— | | | | | | | | | |
| Reading Room | 30 | C | 9.0 | 15.0 | 25.0 | C | 15.0 | 35.0 | 50.0 |
| Office Buildings— | | | | | | | | | |
| Bookkeeping, Typing, and Accounting | 50 | C | 12.0 | 17.0 | 24.0 | C | 25.0 | 35.0 | 50.0 |
| Post Office— | | | | | | | | | |
| Lobby | 20 | B | 4.8 | 6.6 | 9.8 | B | 10.0 | 14.0 | 22.0 |
| Sorting, Mailing, and File Room | 30 | B | 7.2 | 10.0 | 15.0 | B | 15.0 | 21.0 | 33.0 |
| Professional Offices— | | | | | | | | | |
| Waiting Rooms and Consultation Rooms | 30 | B | 6.8 | 11.0 | 18.0 | B | 14.0 | 20.0 | 35.0 |
| Restaurants, Lunch Rooms, Cafeterias— | | | | | | | | | |
| Dining Areas | 10 | C | 3.4 | 6.0 | 10.0 | C | 7.0 | 10.0 | 20.0 |
| Schools— | | | | | | | | | |
| Auditoriums | 10 | C | 3.5 | 5.0 | 7.0 | C | 7.0 | 13.0 | 20.0 |
| Class and Study Rooms | 30 | C | 9.00 | 12.0 | 18.0 | C | 15.0 | 21.0 | 33.0 |
| Store Interiors | 40 | B | 10.0 | 14.0 | 18.0 | B | 20.0 | 25.0 | 35.0 |
| Theaters and Motion Picture Houses— | | | | | | | | | |
| Auditoriums (Darkened) | 0.1 | B | .5 | .8 | 1.0 | B | 1.0 | 1.4 | 1.8 |
| Industrial Interiors[2] | 30 | A | 5.0 | 7.0 | 9.0 | A | 12.0 | 15.0 | 20.0 |

[1]A—direct lighting system; B—semi-direct or general diffuse lighting system; C—indirect or semi-indirect lighting system.

The type system has been indicated to allow the heating and ventilating engineer to make an adjustment if he is aware that a different type lighting system is being installed.

[2]General illumination only with industrial RLM lighting fixtures.

NOTE: Fixtures for "low," "average," and "high" values are based on rooms having approximately the following ratios of room width to ceiling height and for recommended footcandle levels for each area: Low—6.0; Average—2.5; High—1.0.

**Aside from room shape, room surface reflection factors and the type fixture will cause considerable variation. While an attempt was made to base the values on typical fixtures and room reflectances, it is to be expected that wide variation in Btu's per square foot per hour will occur.**

**—FROM Strock, Handbook of Heating, Ventilation and Air Conditioning**

## TABLE 5-3
## Heat Given Off by Electric Motors

| Nameplate[2] or Brake Horsepower | Full Load Motor Efficiency Percent | Continuous Operation[1] — Location of Equipment with Respect to Conditioned Space or Air Steam[3]: Motor In - Driven Machine in $\frac{HP \times 2545}{\% \, Eff.}$ | Motor Out - Driven Machine in HP x 2545 | Motor In - Driven Machine Out $\frac{HP \times 2545 \, (1 - \% \, Eff.)}{\% \, Eff.}$ |
|---|---|---|---|---|
| | | Btu per Hour | | |
| 1/20 | 40 | 320 | 130 | 190 |
| 1/12 | 49 | 430 | 210 | 220 |
| 1/8 | 55 | 580 | 320 | 260 |
| 1/6 | 60 | 710 | 430 | 280 |
| 1/4 | 64 | 1,000 | 640 | 360 |
| 1/3 | 66 | 1,290 | 850 | 440 |
| 1/2 | 70 | 1,820 | 1,280 | 540 |
| 3/4 | 72 | 2,680 | 1,930 | 750 |
| 1 | 79 | 3,220 | 2,540 | 680 |
| 1-1/2 | 80 | 4,770 | 3,820 | 950 |
| 2 | 80 | 6,380 | 5,100 | 1,280 |
| 3 | 81 | 9,450 | 7,650 | 1,800 |
| 5 | 82 | 15,600 | 12,800 | 2,800 |
| 7-1/2 | 85 | 22,500 | 19,100 | 3,400 |
| 10 | 85 | 30,000 | 25,500 | 4,500 |
| 15 | 86 | 44,500 | 38,200 | 6,300 |
| 20 | 87 | 58,500 | 51,000 | 7,500 |
| 25 | 88 | 72,400 | 63,600 | 8,800 |
| 30 | 89 | 85,800 | 76,400 | 9,400 |
| 40 | 89 | 115,000 | 102,000 | 13,000 |
| 50 | 89 | 143,000 | 127,000 | 16,000 |
| 60 | 89 | 172,000 | 153,000 | 19,000 |
| 75 | 90 | 212,000 | 191,000 | 21,000 |
| 100 | 90 | 284,000 | 255,000 | 29,000 |
| 125 | 90 | 354,000 | 318,000 | 36,000 |
| 150 | 91 | 420,000 | 382,000 | 38,000 |
| 200 | 91 | 560,000 | 510,000 | 50,000 |
| 250 | 91 | 700,000 | 636,000 | 64,000 |

1 For intermittent operation, an appropriate usage factor should be used, preferably measured.

2 If motors are overloaded and amount of overloading is unknown, multiply the above heat gain factors by the following maximum service factors:

**Maximum Service Factors**

| Horsepower | 1/20-1/8 | 1/6-1/3 | 1/2-3/4 | 1 | $1\frac{1}{2}$-2 | 3-250 |
|---|---|---|---|---|---|---|
| AC Open Type | 1.4 | 1.35 | 1.25 | 1.25 | 1.20 | 1.15 |
| DC Open Type | --- | -- | -- | 1.15 | 1.15 | 1.15 |

3 For a fan or pump in air conditioned space, exhausting air and pumping fluid to outside of space, use values in last column.

## TABLE 5-4
## Heat Given Off by Personnel

| DEGREE OF ACTIVITY | TYPICAL APPLICATION | Metabolic (Adult Male) Btu/hr | Average Adjusted Metabolic Rate[1] Btu/hr | ROOM DRY-BULB TEMPERATURE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 82 F Btu/hr | | 80 F Btu/hr | | 78 F Btu/hr | | 75 F Btu/hr | | 70 F Btu/hr | |
| | | | | Sensible | Latent | Sensible | Latent | Sensible | Latent | Sensible | Latent | Sensible | Latent |
| Seated at rest | Theater, Grade School | 390 | 350 | 175 | 175 | 195 | 155 | 210 | 140 | 230 | 120 | 260 | 90 |
| Seated, very light work | High School | 450 | 400 | 180 | 220 | 195 | 205 | 215 | 185 | 240 | 160 | 275 | 125 |
| Office worker | Offices | 475 | 450 | 180 | 270 | 200 | 250 | 215 | 235 | 245 | 205 | 285 | 165 |
| Sedentary work | Mess hall [2] | 500 | 550 | 190 | 360 | 220 | 330 | 240 | 310 | 280 | 270 | 320 | 230 |
| Light bench work | Factory, light work | 800 | 750 | 190 | 560 | 220 | 530 | 245 | 505 | 295 | 455 | 365 | 385 |
| Moderate dancing | Dance Hall | 900 | 850 | 220 | 630 | 245 | 605 | 275 | 575 | 325 | 525 | 400 | 450 |
| Walking, 3 mph | Factory, fairly heavy work | 1000 | 1000 | 270 | 730 | 300 | 700 | 330 | 670 | 380 | 620 | 460 | 540 |
| Heavy work | Factory | 1500 | 1450 | 450 | 1000 | 465 | 985 | 485 | 965 | 525 | 925 | 605 | 845 |

1 Adjusted Metabolic Rate is the metabolic rate to be applied to a mixed group of people with a typical percent composition based on the following factors:

Metabolic rate, adult female = Metabolic rate, adult male x 0.85
Metabolic rate, children = Metabolic rate, adult male x 0.75

2 Mess Hall - Values for this application include 60 Btu per hr. for food per individual (30 Btu sensible and 30 Btu latent heat per hr).

TABLE 5-5
Approximate Heat Given Off by Steam Heated Appliances

| APPLIANCE | STEAM USAGE pounds/hr | HEAT GAIN TO SPACE Btu/hr/total |
|---|---|---|
| Steam Jacketed Kettle | 2.0 per gal contents | 935 per gal contents |
| Steam Table | 1.6 per sq ft table Surface | 770 per sq ft surface |
| Bain Marie (vegetable & sauce warmer) | 3.2 per sq ft table Surface | 1,535 per sq ft surface |
| Plate Warmer | 1.5 per cu ft of vol | 720 per cu ft vol |
| Urn | 3.0 per gal contents | 1.420 per gal contents |
| Vegetable Steamer | 2.0 per gal contents | 935 per gal contents |
| Egg Boiler | 5.0 per compartment | 2,300 per compartment |
| Tray Washer | 0.17 per person served | 800 per person served |
| Cup Washer | 0.08 per person served | 400 per person served |
| Dishwasher | 0.33 per person served | 1580 per person served |

These allowances are for unhooded, unvented appliances: hooding cuts heat gain, 25%, venting, 50%.

TABLE 5-6
Heat Given Off by Kitchen Appliances

| Heat Gain, to Space Btu/hour | | |
|---|---|---|
| APPLIANCE | ELECTRIC | GAS |
| Coffee Maker - 2 gal | 3,420 | 4,400 |
| 5 gal | 5,500 | 8,000 |
| 10 gal | 8,500 | 10,000 |
| Water Heater - 5 gal | 8,200 | 15,000 |
| 10 gal | 13,700 | 16,000 |
| Food Warmer, Water Pan, per burner | 900 | 1,500 |
| Fryer, Deep, per lb of fat | 360 | 420 |
| Griddle, per sq ft | 2,750 | 5,000 |
| Grille, Small | 8,000 | 10,000 |
| Large | 15,000 | 18,000 |
| Hot Plate, Simmer | 2,000 | 2,000 |
| Full On | 6,000 | 9,000 |
| Ovens, per cu ft | 5,000 | 8,000 |
| Ranges, per burner | 7,000 | 8,500 |
| Toaster, Continuous 2 Slices Wide | 6,400 | 11,000 |

Where hooded, these allowances should be decreased 50 percent.

TABLE 5-7
Quick Estimate Air Conditioning[1]

| Building Use | Air Conditioning sq ft/ton |
|---|---|
| Auditorium | 100 |
| School | 150 |
| Office | 190 |
| Residence | 400 |
| BOQ | 220 |
| Barracks | 220 |
| Mess Halls | 85 |
| Hospitals | |
| Patient Rooms | 180 |
| Public Areas | 110 |
| Libraries | 200 |

[1]Approximations for outside design conditions of 95°F and 80°F WB (Gulf Coast and Florida as a datum) and inside conditions of 76°F DB and 50 percent RH.

TABLE 5-8
Major Dry Bulb-Wet Bulb Zones in Continental United States

| Zone No. | Geographical Region | Degree F Dry Bulb | Degree F Wet Bulb | Percent (As Decimal) of Zone 1 |
|---|---|---|---|---|
| 1 | Florida and Gulf Coast | 95 | 80 | 1.00 |
| 2 | Interior So. Calif. and Bakersfield California | 100 | 78 | 0.98 |
| 3 | Eastern Missouri and St. Louis, Missouri | 98 | 78 | 0.97 |
| 4 | Maryland, East Coast to Florida | 95 | 78 | 0.94 |
| 5 | San Joaquin Valley Calif. and South Arizona | 105 | 75 | 0.91 |
| 6 | Illinois, Wisconsin, Iowa and Chicago, Illinois | 95 | 75 | 0.88 |
| 7 | Massachusetts, Connecticut and Rhode Island | 91 | 75 | 0.84 |
| 8 | Los Angeles, California and adjacent area | 90 | 70 | 0.73 |
| 9 | San Diego, California and adjacent area | 85 | 68 | 0.67 |
| 10 | Puget Sound, Washington; Portland, Oregon; San Francisco Bay Area, Calif. | 85 | 65 | 0.61 |

## CHAPTER 6. UTILITIES COST ESTIMATION

6.1 GENERAL. The procedures and formulae developed in the preceding sections can be readily adapted for utilities cost estimation by approaching these methods with projected weather, population, and unit cost data rather than data recorded for a specific target period. The accuracy of these estimates can, of course, be only as good as the projected data. If, for example, monthly degree days are observed to deviate widely from a historical norm, an established future steam/heat cost cannot be very reliable, and should be used with extreme care for budgeting purposes. Sound judgment in the application of the techniques presented here will lead to useful and efficient budgeting practice.

6.2 ELECTRICAL ESTIMATES. In recent years, electric loads have tended to increase at a steady rate, as a straight line function, due to gradual increases in use of electronic equipment, air conditioning, computerized and automated systems, improvements in lighting, etc. As the first step in estimating future energy and demand requirements, future loads should be projected on the basis of <u>normal</u> increase over at least the past five years; that is, using records of past consumption, obtain the slope of the load curve, disregarding discontinuities due to new construction and the like, to obtain the normal increment of increase. Where past records are not available, as at new activities, or distribution feeders handling new areas at other activities, use a curve based on a 100 percent increase each 10 years. To calculate the effect of planned major changes, other than the normal projected increases described above, use Table 2-7 and Tables referenced therein. For example, if a building is to be added, or abandoned, or its usage changed, the changes may be estimated using the area factors (Table 2-3), the load factors based on planned changes in major loads (2 kw. or over)(Table 2-3) and calculating estimated changes in energy and demand (Table 2-4). These changes are then superimposed on the projected loads, as obtained on the basis of past history.

The future loads should be estimated on a feeder by feeder basis, as described in Chapter 2. Where planned new construction calls for addition of a substation and associated feeders, the estimated loads for this distribution subsystem would be obtained exactly as described in Chapter 2 and then increased by an amount determined by the normal increase curve for the activity as a whole. It is important to take all factors into account. For example, a substantial amount of new construction will normally mean more outdoor lighting; an increase in dockside maintenance facilities will normally result in more hotel service for ships in a given period of time.

6.3 POTABLE WATER ESTIMATE. The projected demand for potable water consists of industrial and domestic consumption. Estimates of future industrial consumption must be based on a knowledge of the mission and industrial plant of the activity. Tables 3-2, 3-5, and 3-6 are applicable to industrial consumption of water. Domestic consumption, $W_d$, usually depends on the population of the activity and can therefore be estimated by multiplying a per capita water allowance (Table 3-4) by the projected population and by the length of the period. Water requirements for irrigation may constitute a large part of the domestic water use at some activities. If projected irrigation requirements are to be included in the budget, they should be derived as described in Chapter 3.

The potable water cost estimate, $C_W$, is now found by multiplying the sum of the projected domestic and industrial water requirements by a projected unit cost

$$C_w = (W_d + W_i) \text{ x unit cost delivered.}$$

6.4 STEAM/HEAT ESTIMATE. The projected demand for heating is composed of three components:

(1) Building heating allowance, $H_b$, a projected heat quantity requirement for a given building by multiplying the heat allowance factor (as recorded on the Building Heating Target Information Form, Table 4-5) by the building volume (recorded on the same form) and by the projected heating degree days for the period. If new buildings or additions to old buildings are to come into use during the budget period, a new heat allowance factor should be generated as described in Chapter 4, and used as above for the proper portion of the budgeting period. Heating degree days can be projected from local historical averages as recorded by the weather bureau, or from heating hand books and specifications.

$$H_b = \text{allowance factor X volume X degree days.}$$

(2) Water heating allowance, $H_W$; the heat quantity for domestic water heating is derived by multiplying an average allowance factor by an equivalent full time population and by the length of the budgeting period. The allowance factor may be an observed norm, or a more precise estimate by the EFD, depending on how accurate the budget need be. (A satisfactory first estimate of an allowance factor would be 1,000,000 BTU/man/month.)

$$H_w = \text{allowance factor X an equivalent number of full-time personnel X length of period.}$$

(3) Special uses, $H_s$; an allowance for such uses as ships, galley equipment, and process equipment; this allowance must be based on knowledge of the activity's mission and equipment. Table 4-2, Tables 4-6 through 4-26, and Figures 4-1 through 4-5 list requirements for various heat-using equipment.

The total annual heating cost, $C_h$, is now found by totaling the heating quantities estimates and multiplying this total by a projected unit cost.

$$C_h = (H_b + H_w + H_s) \text{ X unit cost delivered.}$$

6.5 AIR CONDITIONING ESTIMATES. Energy requirement for air conditioning, $A_E$, can be estimated by multiplying the total tonnages (Tables 5-1 and 5-7) by the allowed energy per ton figure (target summary sheets) multiplied by an equipment load factor, estimated for the particular application, times the number of hours above 80 degrees F. during the cooling season.

$$A_E = \text{tonnage X KW or BTU per ton X load factor X hours above 80 degrees F.}$$

The additional energy cost for air conditioning, $C_{AE}$, is now found by multiplying the energy requirement estimate by the unit cost delivered for the utility providing the energy.

$$C_{AE} = A_E \text{ X Unit Cost delivered.}$$

Additional annual water requirement for air conditioning, $A_W$, can be estimated by multiplying the equipment tonnage by an estimated water usage factor, in gallons per ton (from Chapter 3), multiplied by the number of hours that the cooling equipment will be running:

$$A_W = \text{tonnage X allowance gal./ton-hr. X hrs.}$$

The additional water cost for air conditioning, $C_{AW}$, can now be found by multiplying the water requirement by the activity's most recent unit cost delivered for water.

$$C_{AW} = A_W \text{ X unit cost delivered.}$$

The total annual cost for air conditioning, $C_A$, is now developed by totaling the individual estimated utilities costs for steam or electrical energy, water and sewage.

$$C_A = C_{AE} + C_{AW} + C_{AS}.$$

TABLE 6-1 (1 of 2)
Example of Proposed Annual Utilities Cost Estimation Method

Building Information:

| | |
|---|---|
| Type: | Barrack, frame construction |
| Area: | 10,300 sq ft |
| Population: | 82 men (assumed 125 sq ft/man) |
| Location: | |
| Weather Data: | 31°F Design Temp., 914-65°F Degree days<br>2,169 air conditioning hrs above 80°F (from MO-303 and NAVDOCKS P-89) |
| Unit Costs: | Heating; $0.30/million Btu<br>Water; $0.38/thousand gal<br>Sewage; $0.35/thousand gal<br>Electricity; $9.7/thousand Kw-hr<br>(These are delivered unit costs from NAVCOMPT Form 2127 for the activity) |

A. Heating:

(1) Building heating allowance =
heat allowance factor x volume x degree days in period
1.85 Btu/$ft^3$/DD x (9 ft x 10,300 $ft^2$) x 944DD = 162 x $10^6$ Btu

(2) Water heating allowance =
Heat allowance factor x full time residents x months
1 x $10^6$ Btu/man/month x 82 men x 12 months = 984 x $10^6$ Btu

(3) Special usage =
none in this example

(4) Total heating allowance =
building heating + water heating + special use
162 x $10^6$ Btu + 984 x $10^6$ Btu = 1,146 x $10^6$ Btu

(5) Annual Heating Cost =
Annual quantity allowance x unit cost delivered
1,146 x $10^6$ Btu's x 0.30 $/$10^6$ Btu's = $344.00

B. Electricity:

(1) Electrical energy allowance =
area factor x area
0.22 x 10.3 x $10^3$ sq ft = 2.3
+ load factor x load
0.16 x 29 kw = 4.6
6.9

(2) Annual energy consumption =
energy allowance x hours x loss allowance
6.9 x 8,760 x 1.06 = 64,000 kw-hr

TABLE 6-1 (2 of 2)
Example of Proposed Annual Utilities Cost Estimation Method

(3) Annual electrical cost =
annual quantity x unit cost delivered
64 million kw-hr x 9.7\$/million kw-hr = \$621.00

C. Water:
(1) Water usage =
Equivalent residents No. x allowance x days in period
82 x 65 gal/man/day x 365 days = $1.95 \times 10^6$ gal

(2) Annual Cost =
annual water usage x unit cost delivered
$1.95 \times 10^6$ gal x 0.38 \$/$10^3$ gal = \$741.00

D. Air Conditioning:
(1) Electricity for AC =
tonnage x kw/ton x load factor x hours above 80°F
40 tons x 1.14 kw ton x 0.50 x 2,169 hours = $49.5 \times 10^3$ kw-hr

(2) Annual Electrical cost for AC =
energy estimate x unit cost delivered
$49.5 \times 10^3$ kw-hr x 9.7 \$/million kw-hr = \$480.00

(3) Water quantity for AC =
tons x gal/ton-hr allowance x hours above 80°F
40 tons x 3 gal/ton-hr x 2,169 hours = $260 \times 10^3$ gal

(4) Annual water cost for AC =
water quantity estimate x unit cost delivered
$260 \times 10^3$ gal x 0.38 \$/$10^3$ gal = \$99.00